B.Sc. ENVIRONMENTAL SCIENCE: SEMESTER- III

		SEMESTER III	Credit	SEMESTER IV	Credit
Core Elective-I	Theory	**Analytical Techniques**	3	**POPULATION, DEVELOPMENT AND ENVIRONMENT**	3
	Practical	Analytical Chemistry	2	Chemistry	2
Core Elective-II	Theory	**NATURE OF INDIA'S ENVIRONMENT- I**	3	**NATURE OF INDIA'S ENVIRONMENT II**	3
	Practical	Environments Practicals	2	Environments Practicals	2
Core Elective-III	Theory	**Biostatastics and Its application-II**	3	**ENVIRONMENTAL ZOOLOGY**	3
	Practical	**Problems from the syllabus**	2	Zoology	2
Core Elective-IV	Theory	**ENVIRONMENTAL MICROBIOLOGY AND BOTANY**	3	**BIOLOGICAL ENVIRONMENT**	3
	Practical	Biology & Botany	2	Biology	2
Core Compulsory course	Theory	**English**	3	**English**	3
Social Orientation course	Theory	**Any One from the list (Self learning approach)**	1	**Any One from the list (Self learning approach)**	1
Total Credits			24		24

& IV

SOCIAL ORIENTATION COURSE: One of the following courses can be opted:

- ***Disaster Management***
- ***Pollution and its control***
- ***RTI Act & Consumer Act***
- ***Basics of Computers***
- ***Local Governance***
- ***Social Work***

SEMESTER – III

CORE ELECTIVE– I: Analytical Techniques

Unit I Separation Techniques: 15 Marks

- Chromatography- Principles, application methodology and types of planar and column chromatography
- HPLC, GC, Ion-exchange, Affinity and Gel chromatography.
- Electrophoresis- Principles and applications of paper, gel, SDS PAGE,
- Centrifugation

Unit II Spectrometry: 15 Marks

- Principles and instrumentation, UV/visible/IR Spectrophotometry
- Atomic absorption spectrometer,
- Mass spectrometry,

Unit III Instrumentation: 15 Marks

- High Volume sampler, low volume sampler
- Ovens, shakers, centrifuge, pH meter, Electronic Balance
- BOD, Laminar Flow hood, glassbeed sterilizers, Autoclave
- Microscopy – Principles and application.

Unit IV Microscopy: 15 Marks

- Principle and application of light, phase contrast, fluorescence
- Scanning and transmission electron microscopy, scanning tunneling microscopy
- Atomic force microscopy, confocal microscopy Cytophotometry and flow cytometry, fixation and staining

List of Practical: Analytical Chemistry

Determination of phenol from water
Estimation of sulfates in water
Estimation of nitrates in water
Estimtion of phosphate in water/soil
Qualitative analysis of mixtures containing 4 radicals
Identification of organic compounds and their derivitisation
Complex metric titration
Effect of acidic atmosphere on metal corrosion

PATTERN OF QUESTION PAPER

Total Marks : 60 , Duration : Three Hours
Passing standard: 24 Marks

FOR SEMESTER-END EXAMS

1. **Internal options are compulsory (i.e. Q.1 or Q.1; Q.2 or Q.2 etc.)**
2. **There are four questions (Q. 1 to Q. 4) each question carries 15 marks The structure for the questions is as under:**

Questions	Section	Marks
Question – 1 **UNIT – I**	**A (Objective type)** ***(no internal option)***	**5 marks**
	B (Descriptive - Essay type - Short notes ***with internal option)***	**10 marks**
Question – 2 **UNIT – II**	**A –do-**	**5 marks**
	B –do-	**10 marks**
Question – 3 **UNIT – III**	**A –do-**	**5 marks**
	B –do-	**10 marks**
Question – 4 **UNIT – IV**	**A –do-**	**5 marks**
	B –do-	**10 marks**

Types of questions for section A are varied: like: one line answers/ two line answers/ definitions/ reasoning/ derivations of equations/ derivations of sums/ drawing small figures/ matching the figures etc..

CORE ELECTIVE– II: NATURE OF INDIA'S ENVIRONMENT- I

Unit I Land Resources:
Marks-15

- Land utilization, land use & land cover classification. Soils- Types and distribution, soil loss; soil salinity; soil erosion and conservation.
- Impact of irrigation-water logging, poor drainage, soil infertility; reclamation; nutrient loss; fertilizers. Desertification of the Thar; degradation of hillsides

Unit II Water resources:
Marks-15

- Concept of hydrological cycle, monsoon distribution, surface & ground water resources, utilization for various purposes. River valley projects. Effect of dams.

Unit III Forest and Wild Life Resources:
Marks-15

- Area, distribution and types of forest, forest cover, major/minor forest products. Problems of over grazing, fuel wood.
- Social forestry with particular reference to a Gujarat. Chipko & Appiko movement

Unit IV Wild life Resources:
Marks-15

- Types and distribution. Impact of people on wild life and ecology; endangered species of India. Conservation of wild life
- Wildlife resources of India and different institutes working for Wild life conservation in India and abroad.
- Concept of Biological Diversity – wild life conservation program in India
- Millennium Development Goal and Biodiversity conservation in India

List of Practical

Principles and basic concepts of remote sensing
Determination of photo scales, heights and slopes

PATTERN OF QUESTION PAPER

Total Marks : 60 , Duration : Three Hours
Passing standard: 24 Marks

FOR SEMESTER-END EXAMS

1. **Internal options are compulsory (i.e. Q.1 or Q.1; Q.2 or Q.2 etc.)**
2. **There are four questions (Q. 1 to Q. 4) each question carries 15 marks The structure for the questions is as under:**

Questions	Section	Marks
Question – 1 **UNIT – I**	**A (Objective type)** ***(no internal option)***	**5 marks**
	B (Descriptive - Essay type - Short notes ***with internal option)***	**10 marks**
Question – 2 **UNIT – II**	**A –do-**	**5 marks**
	B –do-	**10 marks**
Question – 3 **UNIT – III**	**A –do-**	**5 marks**
	B –do-	**10 marks**
Question – 4 **UNIT – IV**	**A –do-**	**5 marks**
	B –do-	**10 marks**

Types of questions for section A are varied: like: one line answers/ two line answers/ definitions/ reasoning/ derivations of equations/ derivations of sums/ drawing small figures/ matching the figures etc..

CORE ELECTIVE-III : Bio-Statistics and its application-II

Unit-1 TIME SERIES: Marks-15

Definition and Meaning of time series. Components of time series. Trend, Seasonal, Cyclic and Random components, Elimination of trend by the method of Moving average, method of curve fitting, using or ordinary least squares principle only, curve fitting for numerical data for linear, quadratic and exponential case only.

Unit-2 LARGE SAMPLE TEST: Marks-15

Statement of a hypothesis, null hypothesis, level of significance, critical region or rejection region, testing of hypothesis, two types of errors, standard error of statistic, significance of mean(s) and proportion(s) in case of one and two samples.

SMALL SAMPLE TEST:

Definition of t and F statistics, degree of freedom, properties of t and F distributions, use of t and F tests. Z-test.

Unit-3 CHI-SQUARE TEST: Marks-15

Definition of Chi-square test as large sample Statistic. Properties of Chi-square distribution without proof. Application of Chi-square test. Test of independence of attributes up to 3x3 contingency table. Derivation of Chi-square in 2x2 contingency table. Goodness of fit test.

Unit-4 ANALYSIS OF VARIANCE: Marks-15

Concept of analysis of variance, Example on One way and Two way analysis of variance.

PRACTICALS:

PRACTICALS ARE DERIVED FROM THE ABOVE MENTIONED SYLLABUS OF STATISTICS

PATTERN OF QUESTION PAPER

Total Marks : 60 , Duration : Three Hours
Passing standard: 24 Marks

FOR SEMESTER-END EXAMS

1. **Internal options are compulsory (i.e. Q.1 or Q.1; Q.2 or Q.2 etc.)**
2. **There are four questions (Q. 1 to Q. 4) each question carries 15 marks The structure for the questions is as under:**

Questions	Section	Marks
Question – 1 **UNIT – I**	**A (Objective type)** ***(no internal option)***	**5 marks**
	B (Descriptive - Essay type - Short notes ***with internal option)***	**10 marks**
Question – 2 **UNIT – II**	**A –do-**	**5 marks**
	B –do-	**10 marks**
Question – 3 **UNIT – III**	**A –do-**	**5 marks**
	B –do-	**10 marks**
Question – 4 **UNIT – IV**	**A –do-**	**5 marks**
	B –do-	**10 marks**

Types of questions for section A are varied: like: one line answers/ two line answers/ definitions/ reasoning/ derivations of equations/ derivations of sums/ drawing small figures/ matching the figures etc..

CORE ELECTIVE-IV : ENVIRONMENTAL MICROBIOLOGY AND BOTANY

Unit I Agricultural, food & Dairy Microbiology: Marks-15

- Production of bacterial bio-fertilizers, criteria for strain selection, steps involved in production, microbial insecticides & herbicides, biological nitrogen fixation.
- Microbial flora of fresh foods, microbial spoilage of food, microbial examination of food, food preservation, sources of micro-organisms in milk, microbial examination of milk, pasteurization.

Unit II Water & Air Microbiology, Microbial diseases: Marks-15

- Types of water (atmospheric, surface ground stores etc) marine microbiology, fresh water microbiology, microbial analysis of water, salinity standards
- Indoor aero microbiology , aero microbiology of pharmacy, hospitals, storage materials (library, wall Paintings) aero allergens, phylloplane micro flora, microbial interactions on leaf surface
- Air-borne, food-borne, water-borne seed borne microbial disorders, their control, antibiotics and other chemotherapeutic agents, mode of action

Unit III Plant productivity:
Marks-15

- Plant productivity
- Measurement of productivity
- Factors affecting productivity
- Variations across different ecosystems.
- Ecological energetic, keeping plant productivity as the base.

Unit IV Plant communities, Succession and climate community: Marks-15

- Community concept
- Structure – horizontal and vertical stratification
- Stability & complexity
- Variations in plant communities across different ecosystems

PRACTICALS:

Demonstration of the presence of microorganisms in air water soil skin teeth etc.
Isolation of microorganism: stream plate technique
Monochrome and gram staining
Enumeration of microorganism: spread plate technique
Study of oligodynamic action of copper
Crowded plate technique for isolation of antibiotic producting microorganisms
Most probable number technique, IMVic test
Aerobic and anaerobic cultivation – sloopy agar method
Cultivation of microorganisms in different types of media
Isolation of Rizobium from root nodules , Assay for enzyme nitrate
Isolation of microbes from milk, Pasteurization of milk, Formation of litter
To detect the level of N and P from soi, Study of aeromicroflora
Study of microflora of water

Isolation of antibiotic producing microorganism
To test the sensitivity to antibiotics
To isolate the micro-organism from food materials
Pollution related symptoms observed in plants
Vegetal cover mapping

PATTERN OF QUESTION PAPER

Total Marks : 60 , Duration : Three Hours
Passing standard: 24 Marks

FOR SEMESTER-END EXAMS

3. **Internal options are compulsory (i.e. Q.1 or Q.1; Q.2 or Q.2 etc.)**
4. **There are four questions (Q. 1 to Q. 4) each question carries 15 marks The structure for the questions is as under:**

Questions	Section	Marks
Question – 1 **UNIT – I**	**A (Objective type)** ***(no internal option)***	**5 marks**
	B (Descriptive - Essay type - Short notes ***with internal option)***	**10 marks**
Question – 2 **UNIT – II**	**A –do-**	**5 marks**
	B –do-	**10 marks**
Question – 3 **UNIT – III**	**A –do-**	**5 marks**
	B –do-	**10 marks**
Question – 4 **UNIT – IV**	**A –do-**	**5 marks**
	B –do-	**10 marks**

Types of questions for section A are varied: like: one line answers/ two line answers/ definitions/ reasoning/ derivations of equations/ derivations of sums/ drawing small figures/ matching the figures etc..

CORE Compulsory: English:

YET NOT DECIDED BY THE CONCERN BOARD.

PATTERN OF QUESTION PAPER

Total Marks : 60 , Duration : Three Hours
Passing standard: 24 Marks

FOR SEMESTER-END EXAMS

1. **Internal options are compulsory (i.e. Q.1 or Q.1; Q.2 or Q.2 etc.)**
2. **There are four questions (Q. 1 to Q. 4) each question carries 15 marks The structure for the questions is as under:**

Questions	Section	Marks
Question – 1 **UNIT – I**	**A (Objective type)** ***(no internal option)***	**5 marks**
	B (Descriptive - Essay type - Short notes ***with internal option)***	**10 marks**
Question – 2 **UNIT – II**	**A –do-**	**5 marks**

	B –do-	**10 marks**
Question – 3 UNIT – III	**A –do-**	**5 marks**
	B –do-	**10 marks**
Question – 4 UNIT – IV	**A –do-**	**5 marks**
	B –do-	**10 marks**

Types of questions for section A are varied: like: one line answers/ two line answers/ definitions/ reasoning/ derivations of equations/ derivations of sums/ drawing small figures/ matching the figures etc..

Social Orientation Course: Self Approach Study: CREDIT-1

Any one opted from the list provided by the University given below.

- ***Disaster Management***
- ***Pollution and its control***
- ***RTI Act & Consumer Act***
- ***Basics of Computers***
- ***Local Governance***
- ***Social Work***

SEMESTER – IV

CORE ELECTIVE– I: POPULATION, DEVELOPMENT AND ENVIRONMENT

Unit I Environment and Demography:
Marks-15

- Demographic attributes, demographic transition, growth, distribution, density, movement, events responsible for population change
- Population and resources-optimum population, over-population, under-population, Ackermaan's population resource regions
- Human activities and changing environment

Unit II Agriculture activity and Human settlement: Marks-15

- Food production, agricultural change, fertilizer, irrigation, pests, biotechnology, sustainable agriculture, aqua agriculture.
- The built environment: location, type and patterns of urban and rural settlements, problems of urban and rural environment

Unit III Mining, War and Industrialization:
Marks-15

Mining: global economic aspects of mineral production, environmental impact on mining, habitat destruction, geomorphological impact, pollution, rehabilitation and reduction of mining damage,

- War: direct war time impacts, nuclear war, indirect war time impacts, limiting the effects of war, environmental causes of conflicts
- Industrialization: global patterns of industrial development, consequences of industrialization on environment
- Environmental effects of transport on land, biosphere, atmosphere and hydrosphere

Unit IV Environment and Development:
Marks-15

- Definition of development, development indicators-demographic, economic and social
- Classification and characteristic of development in different parts of world, impact of development on environment in developed, developing and least developed countries.

List of Practical

Estimation of rate of soil erosion due to agricultural activity
Estimation of pesticides
Estimation of Na & K in soil by flame photometer
Estimation of toxic metals/water e.g. Cd, Cu, Ni, Pb etc.

PATTERN OF QUESTION PAPER

Total Marks : 60 , Duration : Three Hours
Passing standard: 24 Marks

FOR SEMESTER-END EXAMS

1. **Internal options are compulsory (i.e. Q.1 or Q.1; Q.2 or Q.2 etc.)**
2. **There are four questions (Q. 1 to Q. 4) each question carries 15 marks The structure for the questions is as under:**

Questions	Section	Marks
Question – 1 **UNIT – I**	**A (Objective type)** ***(no internal option)***	**5 marks**
	B (Descriptive - Essay type - Short notes ***with internal option)***	**10 marks**
Question – 2 **UNIT – II**	**A –do-**	**5 marks**
	B –do-	**10 marks**
Question – 3 **UNIT – III**	**A –do-**	**5 marks**
	B –do-	**10 marks**
Question – 4 **UNIT – IV**	**A –do-**	**5 marks**
	B –do-	**10 marks**

Types of questions for section A are varied: like: one line answers/ two line answers/ definitions/ reasoning/ derivations of equations/ derivations of sums/ drawing small figures/ matching the figures etc..

CORE ELECTIVE– II: NATURE OF INDIA'S ENVIRONMENT II

Unit I Economic Resources:
Marks-15

- Energy resources : Renewable and non-renewable
- Mineral resources: Metallic, non-metallic & nuclear minerals
- Marine resources – food, mineral & energy

Unit II Habitat & People:
Marks-15

- Urban habitat – urban demography; housing and slums
- Urban water supply and sanitation
- Urban transport
- Rural water supply and sanitation

Unit III Health: Health and poverty; common diseases:
Marks-15

- Impact of environment on life of marine fisher folk and tribes
- Government & environment: Environmental policies

Unit IV Epidemiological Study for Environmental Health:
Marks-15

- Principal of epidemiology and epidemiologic method.
- Aims of Epidemiology, Epidemiological approach, rates and ratios.
- Epidemiologic methods Observational study, Experimental studies and Intervention studies, Descriptive.
- Analytical epidemiology, Experimental epidemiology, Association and causation, use of epidemiology, Infectious epidemiology, Disease transmission.

List of Practical

Mapping of physical and cultural features from stereo pairs of photographs
Extracting of thematic information from satellite data and land use/ land cover mapping

PATTERN OF QUESTION PAPER

Total Marks : 60 , Duration : Three Hours
Passing standard: 24 Marks

FOR SEMESTER-END EXAMS

1. **Internal options are compulsory (i.e. Q.1 or Q.1; Q.2 or Q.2 etc.)**
2. **There are four questions (Q. 1 to Q. 4) each question carries 15 marks The structure for the questions is as under:**

Questions	Section	Marks
Question – 1 **UNIT – I**	**A (Objective type)** ***(no internal option)***	**5 marks**
	B (Descriptive - Essay type - Short notes ***with internal option)***	**10 marks**
Question – 2 **UNIT – II**	**A –do-**	**5 marks**
	B –do-	**10 marks**
Question – 3 **UNIT – III**	**A –do-**	**5 marks**
	B –do-	**10 marks**
Question – 4 **UNIT – IV**	**A –do-**	**5 marks**
	B –do-	**10 marks**

Types of questions for section A are varied: like: one line answers/ two line answers/ definitions/ reasoning/ derivations of equations/ derivations of sums/ drawing small figures/ matching the figures etc..

CORE ELECTIVE-III: ENVIRONMENTAL ZOOLOGY

Unit I Zoogeography & Distribution-I:
Marks-15

- Animals of aquatic, Estuarine, marine, wet lands and mangroves habitats.
- Fauna of tropical rain forest, shrub lands, tundra
- Zoogeographic realm of world
- Zoogeography of India
- Island fauna
- Littoral fauna
- Barriers and dispersal of animals

Unit II Zoogeography &Distribution-II:
Marks-15

- Plankton
- Soil organisms
- Burrowing and soil invertebrates
- Wildlife and wildlife sanctuaries of India
- Wildlife and wildlife sanctuaries of Gujarat

Unit III Adaptations and Evolution of Animals – I:
Marks-15

- Adaptations for aquatic life (pelagaic forms, tubiculous forms, intertidal, deep sea and freshwater forms, Nutritional and Digestive adaptations)
- Adaptations for terrestrial and aerial lie (Respiration, flight, locomotion, feeding, color, mimicry etc.)

Unit IV Adaptations and Evolution of Animals – II:
Marks-15

- Adaptations for High altitude, Deep sea, Desert, Polar regions, cave
- Migration, hibernation and aestivation

List of Practical

Classification up to level of order with examples using specimens and slides
Dissection and permanent mountingvs or demonstration of a) Earthworm and b) Cockroach
Pests; parasites; poisonous animals; social animals; life history; animal of economic importance; animal defensive organs; special adaptations; fossils
Adaptations of animals
Morphology and anatomy of representative animals
Plankton
Aquatic forms

PATTERN OF QUESTION PAPER

Total Marks : 60 , Duration : Three Hours
Passing standard: 24 Marks

FOR SEMESTER-END EXAMS

1. **Internal options are compulsory (i.e. Q.1 or Q.1; Q.2 or Q.2 etc.)**
2. **There are four questions (Q. 1 to Q. 4) each question carries 15 marks The structure for the questions is as under:**

Questions	Section	Marks
Question – 1 **UNIT – I**	**A (Objective type)** ***(no internal option)***	**5 marks**
	B (Descriptive - Essay type - Short notes ***with internal option)***	**10 marks**
Question – 2 **UNIT – II**	**A –do-**	**5 marks**
	B –do-	**10 marks**
Question – 3 **UNIT – III**	**A –do-**	**5 marks**
	B –do-	**10 marks**
Question – 4 **UNIT – IV**	**A –do-**	**5 marks**
	B –do-	**10 marks**

Types of questions for section A are varied: like: one line answers/ two line answers/ definitions/ reasoning/ derivations of equations/ derivations of sums/ drawing small figures/ matching the figures etc..

CORE ELECTIVE-IV: BIOLOGICAL ENVIRONMENT

Unit I Nature of the Biosphere and concept of ecosystem **Marks-15**

- Structure and processes
- Basic principles, scopes its relation to other division of science, biotic, abiotic, structure function, H.T.Odum's energy, language symbols & meanings
- Energy Flow, food webs, trophic levels. Role of micro-organisms in bio-geocycles – Nitrogen, Oxygen, Carbon, Phosphorus, Sulfur, iron cycles, food web accumulation, energy pyramids, concept of limiting factors

Unit II Major Ecosystems of the world **Marks-15**

- Terrestrial, Aquatic (Fresh Water & Marine)
- Types of Biomes and associated organisms,Climatic factors influencing Biomes
- Biomagnification, bioaccumulation, bioagumentation and eutrophication concepts
- Concept of habitat, functional role and niche, keystone species, dominant species, ecotone and edge effect.

Unit III Introduction to Microbiology and their habitat **Marks-15**

- General properties of micro-organisms, characterization, classification and identification.
- Different groups of micro-organisms (types of bacteria, fungi and viruses)
- Ecological groups based on requirement of oxygen, carbon, temperature, habitat & nutrition. Soil microorganisms.
- Environmental selecting factors (physical, chemical, biological), types of microbial habitats (atmospheric, aquatic, terrestrial, marine, deep sea, micro-environments)
- Microbes of the extreme environment (Extremophiles) with respect to tolerance to extremes of temperature, salt, sugar, pressure, chemicals, oxidation, pH, gases, etc.

Unit VI Microbial interactions **Marks-15**

- Competition for survival in nature, role of anti-microbial in nature, types of symbiotic relationships, plant-microbe interaction
- Nutrient cycling: Nitrogen, sulfur, phosphorous, iron & other elements. Role of micro-organisms in biogeochemical cycling.

Practicals: Biological Environment

- Identification of medically important Gm-bacteria, E-coli, P. vulgaris, salmonella spp, shigella spp , Demonstration of ∞ heamolysis, Evaluation of a disinfectant
- Enumeration of microbes in soil, water and air
- Animal community structure of selected biomes and habitats
- Plant community structure of selected biomes and habitats
- Biodiversity index, Population density index, Flora and fauna census

PATTERN OF QUESTION PAPER

Total Marks : 60 , Duration : Three Hours
Passing standard: 24 Marks

FOR SEMESTER-END EXAMS

1. **Internal options are compulsory (i.e. Q.1 or Q.1; Q.2 or Q.2 etc.)**
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	B (Descriptive - Essay type - Short notes ***with internal option)***	**10 marks**
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	B –do-	**10 marks**
Question – 3 **UNIT – III**	**A –do-**	**5 marks**
	B –do-	**10 marks**
Question – 4 **UNIT – IV**	**A –do-**	**5 marks**
	B –do-	**10 marks**

Types of questions for section A are varied: like: one line answers/ two line answers/ definitions/ reasoning/ derivations of equations/ derivations of sums/ drawing small figures/ matching the figures etc..

CORE Compulsory: English

YET NOT DECIDED BY THE CONCERNED BOARD.

PATTERN OF QUESTION PAPER

Total Marks : 60 , Duration : Three Hours
Passing standard: 24 Marks

FOR SEMESTER-END EXAMS

1. **Internal options are compulsory (i.e. Q.1 or Q.1; Q.2 or Q.2 etc.)**
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	B –do-	**10 marks**
Question – 3 UNIT – III	**A –do-**	**5 marks**
	B –do-	**10 marks**
Question – 4 UNIT – IV	**A –do-**	**5 marks**
	B –do-	**10 marks**

Types of questions for section A are varied: like: one line answers/ two line answers/ definitions/ reasoning/ derivations of equations/ derivations of sums/ drawing small figures/ matching the figures etc..

Social Orientation Course: Self Approach Study: CREDIT-1

Any one opted from the list provided by the University given below.

- ***Disaster Management***
- ***Pollution and its control***
- ***RTI Act & Consumer Act***
- ***Basics of Computers***
- ***Local Governance***
- ***Social Work***

B.Sc. Marine Science: SEMESTER- III & IV

		SEMESTER I	Credit	SEMESTER II	Credit
Core Elective-I	Theory	**Physical Oceanography**	3	**Fundamentals of Marine Botany- Paper II**	3
	Practical	Physical	2	Marine Botany	2
Core Elective-II	Theory	**Biology of Marine Organisms-II**	3	**Marine Food Technology**	3
	Practical	Biology	2	Food Technology	2
Core Elective-III	Theory	**Bio-Statistics and Its application-II**	3	**Fundamentals of Fishery Science**	3
	Practical	Derived from the syllabus	2	Fisheries	2
Core Elective-IV	Theory	**Chemical Oceanography- II**	3	**Marine Geology**	3
	Practical	Chemistry	2	Marine Geology	2
Core Compulsory course	Theory	English – I	3	English – II	3
Social Orientation course	Theory	**Any One from the list (Self learning approach)**	1	**Any One from the list (Self learning approach)**	1
Total Credits			24		24

Social Orientation Course: Self Approach Study: CREDIT-1

Any one opted from the list provided by the University given below.

- ***Disaster Management***
- ***Pollution and its control***
- ***RTI Act & Consumer Act***
- ***Basics of Computers***
- ***Local Governance***
- ***Social Work***

B.Sc. Marine Science-Syllabus for Second year

Semester-III

Core Elective-I- Physical Oceanography

Unit-I

Characteristics of Ocean Water - major wind systems - Air-Sea Interaction - ocean-atmosphere coupling - marine weather and climate - evaporation and precipitation processes in the ocean environment.

Unit- 2

El Nino/La Nina - global change - storms and hurricanes - Ocean currents including wind driven systems - eddies - geostrophic currents - upwelling and downwelling processes - tidal waves (tsunamis)

Unit- 3

Waves and their properties - wave generation by wind - deep-water and shallow water waves - effects of waves on sediment and coastal structures - wave refraction and diffraction - impact of waves on beaches.

Unit-4

Physical properties of seawater - vertical and horizontal distributions of salinity and temperature - Identification and significance of water masses.

PRACTICALS FOR PHYSICAL OCEANOGRAPHY

Physical Oceanography

- Collection of Ocean sediment and sediment (Texture) analysis.
- Analysis of GIS and RS Maps
- Operation of sampling instruments-Niskin bottom samplers, Van Veen Grab, Plankton net.

PATTERN OF QUESTION PAPER

Total Marks : 60 , Duration : Three Hours
Passing standard: 24 Marks

FOR SEMESTER-END EXAMS

1. **Internal options are compulsory (i.e. Q.1 or Q.1; Q.2 or Q.2 etc.)**
2. **There are four questions (Q. 1 to Q. 4) each question carries 15 marks The structure for the questions is as under:**

Questions	Section	Marks
Question – 1 **UNIT – I**	**A (Objective type)** ***(no internal option)***	**5 marks**
	B (Descriptive - Essay type - Short notes ***with internal option)***	**10 marks**
Question – 2 **UNIT – II**	**A –do-**	**5 marks**
	B –do-	**10 marks**
Question – 3 **UNIT – III**	**A –do-**	**5 marks**
	B –do-	**10 marks**
Question – 4 **UNIT – IV**	**A –do-**	**5 marks**
	B –do-	**10 marks**

Types of questions for section A are varied: like: one line answers/ two line answers/ definitions/ reasoning/ derivations of equations/ derivations of sums/ drawing small figures/ matching the figures etc..

Core Elective-2: Biology of Marine Organisms-II

UNIT-I

Endogenous rhythms- biological clocks- lunar periodicity and tidal rhythms. Physiology of sense organs- types of organs and functions.

UNIT-II

Physiology of nervous system: structure and functions. Physiology of endocrine system: hormones, neuron-controlled functions, Hormone-induced colour changes

UNIT-III

General account of reproduction in marine organisms – Reproduction in Moluscs, Crustaceans, Polychaetes and Coelenterates and their larval development and settlement process

UNIT-IV

Deep Sea Environmental conditions-Adaptation of deep sea organisms-Food and feeding in deep sea organisms-Life history patterns- Hydrothermal vent communities

PRACTICALS FOR BIOLOGY OF MARINE ORGANISMS-II

Biology of Marine Organisms –II

- Population analysis of *Cerithidea cingulata*.
- Benthic biomass (wet weight) estimation.
- Field trips to study animal communities in different biotopes - mud flat, sandy and rocky shore, mangrove, oyster bed, fouling organisms.

PATTERN OF QUESTION PAPER

Total Marks : 60 , Duration : Three Hours
Passing standard: 24 Marks

FOR SEMESTER-END EXAMS

1. **Internal options are compulsory (i.e. Q.1 or Q.1; Q.2 or Q.2 etc.)**
2. **There are four questions (Q. 1 to Q. 4) each question carries 15 marks The structure for the questions is as under:**

Questions	Section	Marks
Question – 1 **UNIT – I**	**A (Objective type)** ***(no internal option)***	**5 marks**
	B (Descriptive - Essay type - Short notes ***with internal option)***	**10 marks**
Question – 2 **UNIT – II**	**A –do-**	**5 marks**
	B –do-	**10 marks**
Question – 3 **UNIT – III**	**A –do-**	**5 marks**
	B –do-	**10 marks**
Question – 4 **UNIT – IV**	**A –do-**	**5 marks**
	B –do-	**10 marks**

Types of questions for section A are varied: like: one line answers/ two line answers/ definitions/ reasoning/ derivations of equations/ derivations of sums/ drawing small figures/ matching the figures etc..

Core Elective-III:- Bio-Statistics and its application - II

Unit-1 TIME SERIES: Marks-15

Definition and Meaning of time series. Components of time series. Trend, Seasonal, Cyclic and Random components, Elimination of trend by the method of Moving average, method of curve fitting, using or ordinary least squares principle only, curve fitting for numerical data for linear, quadratic and exponential case only.

Unit-2 LARGE SAMPLE TEST: Marks-15

Statement of a hypothesis, null hypothesis, level of significance, critical region or rejection region, testing of hypothesis, two types of errors, standard error of statistic, significance of mean(s) and proportion(s) in case of one and two samples.

SMALL SAMPLE TEST:

Definition of t and F statistics, degree of freedom, properties of t and F distributions, use of t and F tests. Z-test.

Unit-3 CHI-SQUARE TEST: Marks-15

Definition of Chi-square test as large sample Statistic. Properties of Chi-square distribution without proof. Application of Chi-square test. Test of independence of attributes up to 3x3 contingency table. Derivation of Chi-square in 2x2 contingency table. Goodness of fit test.

Unit-4 ANALYSIS OF VARIANCE: Marks-15

Concept of analysis of variance, Example on One way and Two way analysis of variance.

PRACTICALS FOR BIO-STATISTICS AND ITS APPLICATION - II

THE PRACTICALS IS DERIVED FROM THE ABOVE SYLLABUS

PATTERN OF QUESTION PAPER

Total Marks : 60 , Duration : Three Hours
Passing standard: 24 Marks

FOR SEMESTER-END EXAMS

1. **Internal options are compulsory (i.e. Q.1 or Q.1; Q.2 or Q.2 etc.)**
2. **There are four questions (Q. 1 to Q. 4) each question carries 15 marks The structure for the questions is as under:**

Questions	Section	Marks
Question – 1 **UNIT – I**	**A (Objective type)** ***(no internal option)***	**5 marks**
	B (Descriptive - Essay type - Short notes ***with internal option)***	**10 marks**
Question – 2 **UNIT – II**	**A –do-**	**5 marks**
	B –do-	**10 marks**
Question – 3 **UNIT – III**	**A –do-**	**5 marks**
	B –do-	**10 marks**
Question – 4 **UNIT – IV**	**A –do-**	**5 marks**
	B –do-	**10 marks**

Types of questions for section A are varied: like: one line answers/ two line answers/ definitions/ reasoning/ derivations of equations/ derivations of sums/ drawing small figures/ matching the figures etc..

Chemical Oceanography- II

UNIT-I **Marks-15**

Metallic and Non-metallic resources from sea water- Oil and manganese nodules- Major and minor elements of seawater-residence time of elements in seawater- Biological control of trace metals in seawater

UNIT-II **Marks-15**

Chemistry of dissolved Oxygen in oceans and its biological importance-Inter-relationship of Dissolved oxygen with salinity, temperature and other physical factors-Chemistry of carbonates in seawater- pH and its influencing factors.

UNIT- III **Marks-15**

Distribution of gases in the sea. Distribution of nutrients and their cycles. Eutrophication. Dissolved and particulate organic matter in the sea, its chemical nature and properties.

UNIT-IV **Marks-15**

Nutrients and Aerobic Carbon Production and Consumption-Aerobic and Anaerobic digenesis in sediments-Biogenic production- Geochemistry of Ocean sediments.

PRACTICALS FOR THE CHEMICAL OCEANOGRAPHY_II

Chemical Oceanography- II

- Determination of primary production using light and dark bottle techniques.
- Estimation of Salinity, pH, Turbidity, Temperature and Total dissolved salts.
- Determination of Nitrate, Nitrite and Phosphate in samples of Mandvi waters

PATTERN OF QUESTION PAPER

Total Marks : 60 , Duration : Three Hours
Passing standard: 24 Marks

FOR SEMESTER-END EXAMS

1. **Internal options are compulsory (i.e. Q.1 or Q.1; Q.2 or Q.2 etc.)**
2. **There are four questions (Q. 1 to Q. 4) each question carries 15 marks The structure for the questions is as under:**

Questions	Section	Marks
Question – 1 **UNIT – I**	**A (Objective type)** ***(no internal option)***	**5 marks**
	B (Descriptive - Essay type - Short notes ***with internal option)***	**10 marks**
Question – 2 **UNIT – II**	**A –do-**	**5 marks**
	B –do-	**10 marks**
Question – 3 **UNIT – III**	**A –do-**	**5 marks**
	B –do-	**10 marks**
Question – 4 **UNIT – IV**	**A –do-**	**5 marks**
	B –do-	**10 marks**

Types of questions for section A are varied: like: one line answers/ two line answers/ definitions/ reasoning/ derivations of equations/ derivations of sums/ drawing small figures/ matching the figures etc..

Core Compulsory: English:

YET NOT DECIDED BY THE CONCERN BOARD.

PATTERN OF QUESTION PAPER

Total Marks : 60 , Duration : Three Hours
Passing standard: 24 Marks

FOR SEMESTER-END EXAMS

1. **Internal options are compulsory (i.e. Q.1 or Q.1; Q.2 or Q.2 etc.)**
2. **There are four questions (Q. 1 to Q. 4) each question carries 15 marks The structure for the questions is as under:**

Questions	Section	Marks
Question – 1 **UNIT – I**	**A (Objective type)** ***(no internal option)***	**5 marks**
	B (Descriptive - Essay type - Short notes ***with internal option)***	**10 marks**
Question – 2 **UNIT – II**	**A –do-**	**5 marks**
	B –do-	**10 marks**
Question – 3 **UNIT – III**	**A –do-**	**5 marks**
	B –do-	**10 marks**
Question – 4 **UNIT – IV**	**A –do-**	**5 marks**

	B –do-	**10 marks**

Types of questions for section A are varied: like: one line answers/ two line answers/ definitions/ reasoning/ derivations of equations/ derivations of sums/ drawing small figures/ matching the figures etc..

Social Orientation Course: Self Approach Study: CREDIT-1

Any one opted from the list provided by the University given below.

- ***Disaster Management***
- ***Pollution and its control***
- ***RTI Act & Consumer Act***
- ***Basics of Computers***
- ***Local Governance***
- ***Social Work***

Semester IV

Core Elective-1: Fundamentals of Marine Botany-Paper II

UNIT-I

Marine Algal Physiology: Light relationships - Temperature relationships - Response to osmotic changes - Response to pH - Mineral nutrition - Trace elements, Micronutrients and growth factors.

UNIT-II

Utilization of Marine Algae: Marine algae as food, fodder, fertilizer and source of medicine and industrial raw material.

UNIT-III

Cultivation of Algae: Cultivation of Unicellular organisms for single cell proteins on large scale using *Dunaliella*, *Scenedesnus* and *Spirulina* - Mass cultivation of sea weeds such as *Gracilaria*, *Ulva*, *Porphyra* in marine environment by Net cultivation method.

UNIT-IV

Marine Products of economic importance: Agar-agar, Carragenin, Kiesulguhr, Algin, Laminarin, Phycocolloids.

PRACTICALS FOR FUNDAMENTALS OF MARINE BOTANY-PAPER II

Fundamentals of Marine Botany-Paper II

- Identification of phytoplankton of Mandvi coast at generic level (diatoms, dinoflagellates, copepods, chaetognatha and planktonic larvae)
- Identification of locally available macroalgae: Sea grass and halophytes

PATTERN OF QUESTION PAPER

Total Marks : 60 , Duration : Three Hours
Passing standard: 24 Marks

FOR SEMESTER-END EXAMS

1. **Internal options are compulsory (i.e. Q.1 or Q.1; Q.2 or Q.2 etc.)**
2. **There are four questions (Q. 1 to Q. 4) each question carries 15 marks The structure for the questions is as under:**

Questions	Section	Marks

Question – 1 **UNIT – I**	**A (Objective type)** ***(no internal option)***	**5 marks**
	B (Descriptive - Essay type - Short notes ***with internal option)***	**10 marks**
Question – 2 **UNIT – II**	**A –do-**	**5 marks**
	B –do-	**10 marks**
Question – 3 **UNIT – III**	**A –do-**	**5 marks**
	B –do-	**10 marks**
Question – 4 **UNIT – IV**	**A –do-**	**5 marks**
	B –do-	**10 marks**

Types of questions for section A are varied: like: one line answers/ two line answers/ definitions/ reasoning/ derivations of equations/ derivations of sums/ drawing small figures/ matching the figures etc..

Core Elective-2: <u>Marine Food Technology</u>

UNIT I

Introduction, history and development of marine food technology- status of marine food technology industry in India-Harvesting of seafood products such as fish, shellfish, crustaceans, and other types.

UNIT-II

Fish processing and By-products-Types of processing and canning-Commercially important by-products of fish and shellfish- Proximate composition of fish - Classification of protein.

UNIT-III

Commercially important and potential marine species- Microalgae and Macroalgae- Algal products like Carrageenan, Algin, Agar, B-carotene and vitamins. Marine microorganisms as a new biomaterial resource.

UNIT-IV

Processing and packaging of seafood including freezing, canning, Salting, Smoking, Marinating, fermentation - Assessment and management of seafood safety and quality- Case studies in the seafood industry.

PRACTICALS FOR MARINE FOOD TECHNOLOGY

Marine Food Technology

- Visit to nearest sea food industry to see the management of Chill storage studies.
- Handling of fishes, bivalves, prawns and molluscs.
- Evaluation of freshness of fish.

PATTERN OF QUESTION PAPER

Total Marks : 60 , Duration : Three Hours
Passing standard: 24 Marks

FOR SEMESTER-END EXAMS

1. **Internal options are compulsory (i.e. Q.1 or Q.1; Q.2 or Q.2 etc.)**
2. **There are four questions (Q. 1 to Q. 4) each question carries 15 marks The structure for the questions is as under:**

Questions	Section	Marks
Question – 1	**A (Objective type)** ***(no internal option)***	**5 marks**

UNIT – I	**B (Descriptive - Essay type - Short notes *with internal option)***	**10 marks**
Question – 2 UNIT – II	**A –do-**	**5 marks**
	B –do-	**10 marks**
Question – 3 UNIT – III	**A –do-**	**5 marks**
	B –do-	**10 marks**
Question – 4 UNIT – IV	**A –do-**	**5 marks**
	B –do-	**10 marks**

Types of questions for section A are varied: like: one line answers/ two line answers/ definitions/ reasoning/ derivations of equations/ derivations of sums/ drawing small figures/ matching the figures etc..

Core Elective-III: Fundamentals of Fishery Science

UNIT-I

General Morphology and outline classification of fishes - major groups of fishes of the world and their characteristics -Identification of fishes of Gujarat.

UNIT II

Basic Anatomy of fish- digestive, circulatory, respiratory, nervous and reproductive systems- Maturation and spawning in marine fishes- biotic and abiotic factors affecting spawning in fishes.

UNIT- III

Marine fisheries of India- methods of fishery resources survey- acoustic method, survey of fish eggs and larvae-Population Dynamics theory of fishing- unit stock-recruitment- mortality.

UNIT-IV

Principle methods of exploitation of marine fishes- indigenous and modern crafts and gears- Principle methods of fish preservation and processing in India- freezing, canning, pickling, smoking.

PRACTICALS FOR FUNDAMENTALS OF FISHERY SCIENCE

Fundamentals of Fishery Science

- Identification of important edible fishes of Gujarat.
- Visit to conventional aquafarm to see the management of used water
- Gut content analysis to study natural food intake in fishes
- Marine fishery resources – visit to nearest marine landing center – length frequency analysis – catching method –Drawing and reading gear designs.

PATTERN OF QUESTION PAPER

Total Marks : 60 , Duration : Three Hours
Passing standard: 24 Marks

FOR SEMESTER-END EXAMS

1. **Internal options are compulsory (i.e. Q.1 or Q.1; Q.2 or Q.2 etc.)**
2. **There are four questions (Q. 1 to Q. 4) each question carries 15 marks The structure for the questions is as under:**

Questions	Section	Marks
Question – 1 **UNIT – I**	**A (Objective type)** ***(no internal option)***	**5 marks**
	B (Descriptive - Essay type - Short notes	**10**

	with internal option)	**marks**
Question – 2 UNIT – II	**A –do-**	**5 marks**
	B –do-	**10 marks**
Question – 3 UNIT – III	**A –do-**	**5 marks**
	B –do-	**10 marks**
Question – 4 UNIT – IV	**A –do-**	**5 marks**
	B –do-	**10 marks**

Types of questions for section A are varied: like: one line answers/ two line answers/ definitions/ reasoning/ derivations of equations/ derivations of sums/ drawing small figures/ matching the figures etc..

Core Elective-IV: Marine Geology

Unit-1 Physical and Environmental Geology

Introduction to Geology; Branches and scopes of Geology; Physical Geology (Geomorphology, Seas and oceans, Weathering and erosion, Sedimentation, Rivers, Glaciers, Mountains); Environmental Geology-concepts, volcanoes, earthquakes, floods, tsunami as hazard, waste disposals, mining and its impact on environment.

Unit-II Mineralogy and Petrology

Basics of mineralogy, physical properties, classification of minerals, Igneous, sedimentary and metamorphic petrology (their origin, occurrence and common types, basic structures of sedimentary igneous and metamorphic rocks)

Unit-III Geotectonics and Structural Geology

Continental drift and plate tectonics, sea floor spreading, polar wandering, plate boundaries, hot spots, convection currents, internal structure of the earth; Fundamentals of structural Geology, folds, faults, joints

Unit-IV Marine Mineral Resources

Economic mineral resources, Exploration techniques of minerals, Geophysical explorations (Gravity, magnetic, seismic, electrical, GPR etc. methods); Exploration and exploitation methods for marine minerals (petroleum and manganese)

PRACTICALS FOR MARINE GEOLOGY

1. Physical (Megascopic) identification of minerals and rocks
    a. **(Minerals)**Quartz (several types), orthoclase, muscovite, biotite, olivine, hornblende, augite, plagioclase, hypersthene, calcite, barite, gypsum, haematite, magnetite, chromite, pyrite, chalcopyrite, pselomelene, malachite, azurite, apatite, topaz, corundum, fluorite, cuprite, garnet, nepheline, kyanite, sillimanite, talc, tourmaline, beryl, bentonite, chainaclay, bauxite,
    b. **(Rocks)** Sandstone, limestone, shale, conglomerate, fossiliferous limestone, granite, syenite, gabbro, dolerite, diorite, granodiorite, dacite, basalt, andesite, obsidian, pumice, lamprophyre, slate, schists, gneisses, phyllites, granitic gneiss, migmatite
2. Map sections (10 maps of simple geomorphology and geology)
3. Fossil identification (15 common invertebrate mega fossils and 6 microfossils)
4. Arial photo interpretation

PATTERN OF QUESTION PAPER

Total Marks : 60 , Duration : Three Hours
Passing standard: 24 Marks

FOR SEMESTER-END EXAMS

1. **Internal options are compulsory (i.e. Q.1 or Q.1; Q.2 or Q.2 etc.)**
2. **There are four questions (Q. 1 to Q. 4) each question carries 15 marks The structure for the questions is as under:**

Questions	Section	Marks
Question – 1	**A (Objective type)** ***(no internal option)***	**5 marks**

UNIT – I	**B (Descriptive - Essay type - Short notes *with internal option)***	**10 marks**
Question – 2 UNIT – II	**A –do-**	**5 marks**
	B –do-	**10 marks**
Question – 3 UNIT – III	**A –do-**	**5 marks**
	B –do-	**10 marks**
Question – 4 UNIT – IV	**A –do-**	**5 marks**
	B –do-	**10 marks**

Types of questions for section A are varied: like: one line answers/ two line answers/ definitions/ reasoning/ derivations of equations/ derivations of sums/ drawing small figures/ matching the figures etc..

Core Compulsory - English:

YET NOT DECIDED BY THE CONCERN BOARD.

PATTERN OF QUESTION PAPER

Total Marks : 60 , Duration : Three Hours
Passing standard: 24 Marks

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1. **Internal options are compulsory (i.e. Q.1 or Q.1; Q.2 or Q.2 etc.)**
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	B –do-	**10 marks**
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	B –do-	**10 marks**

Types of questions for section A are varied: like: one line answers/ two line answers/ definitions/ reasoning/ derivations of equations/ derivations of sums/ drawing small figures/ matching the figures etc..

Social Orientation Course: Self Approach Study: CREDIT-1

Any one opted from the list provided by the University given below.

- ***Disaster Management***
- ***Pollution and its control***
- ***RTI Act & Consumer Act***
- ***Basics of Computers***
- ***Local Governance***
- ***Social Work***

REFERENCE BOOKS:

LIBRARY BOOKS FOR BSc MARINE SCIENCE AND ENVIRONMENTAL SCIENCE COURSES

S.No	Book Title	
	Oceanography	
1	Contemporary readings in Ocean Sciences- Gorden Pine	
2	Principles of Physical Oceanography by Allen, J.R.L published., Allen and Unwin	
3	Introduction to Physical Oceanography by Knauss, J.A., Prentice-Hall	
4	Introduction to Oceanography by Weighpt	
5	Physical Geology by Arthur Holmes	
8	The waters of the sea by P. Groen., Van Nostrand	
9	Wind waves: Their generation and propagation on the Ocean Surface by Kinsman, B., Prentice –Hall	
10	Chemical Oceanography, Volumes 1 to 9, Academic Press	
11	Estuarine Chemistry by Burton and Liss, Academic Press	
12	Marine Pollution by Gerlach, SA	
13	Olivia J. Fernando, 1999. Sea Water Properties and Dynamics, Dhanesh Publications, Thanjavur.	
14	Duxbury, A.C., A.B. Duxbury and K.A. Sverdrup, 2000. An Introduction to the World's Oceans. 6th Edition. McGraw Hill Companies Inc.	

15	Ghosh, A.K. and R. Mukhopadhyay, 1999. Mineral Wealth of the Ocean. Oxford and IBH Publishing Co.	
16	Riley, J.P and G. Skirrow, 1975 – 1984. Chemical Oceanography, Vols. 1 to 8. Academic Press, London.	
17	Riley, J.P. and R. Chester, 1971. Introduction to Marine Chemistry. Academic Press, London.	
18	Strickland, J.D.H. and T.R. Parsons, 1972. A Practical Handbook of Seawater Analysis. Fisheries Board of Canada, Ottawa, Bulletin, 167.	
Biological Oceanography and Marine Botany		
1	Plankton and Productivity in the Oceans by J.E.G. Raymont, Pergamon Press, 1973	
2	Phytoplankton by A.D. Boney, Edward, Arnold, London, 1975	
3	Marine Botany: An Introduction, Hole Reinhart and Winston Inc., New York, 1966	
4	The Oceans – their Physics, Chemistry and General Biology by H.U. Svedrup, MW.Johnson and R.H. Fleming, Prentice-Hall Inc., New Jercy	
5	Marine Botany by J.D Clinton, John Wiley & Sons Inc., 1988	
6	Studies in Cryptogamic Botany – Vol III by M.R. Vijayaraghavan and Inderdeep Kaur, APFI Publishing Corporation, New Delhi, 1997	
7	Studies in Cryptogamic Botany – Vol II by M.R. Vijayaraghavan and Bela Bhatia, APH Publishing Corporation, New Delhi	
8	Cyanophyta by T.V. Desikachary, IARI, New Delhi, 1959	
9	Properties and products of Algae by J.E. Zajic, Plenum Press, New York, 1970	
10	Paleobotany by Arnold	
11	The biology of Algae by F.E. Round, Arnold Publishers, London, 1965.	
12	Marine Botany by E.Yale Dawson, Holt, Rinehart and Winston, inc, 1966	
13	Mangroves – N. Rajendran- Publication of CAS in Marine Biology, Annamalai University, Tamil nadu	
14	Coral Reefs- R.Rajakumar- Publication of CAS in Marine Biology, Annamalai University, Tamil nadu	
15	Lagoons- S.Baskara Sanjeevi and N. Rajendran-Publication of CAS in Marine Biology, Annamalai University, Tamil nadu	
16	Flowering plants and fern in mangrove ecosystems of India- N. Rajendran and S.Baskara Sanjeevi –Publication of CAS in Marine Biology, Annamalai University, Tamil nadu	
17	How to Know mangroves- L.Kannan, R.Kannan and S.Ravichandran- Publication of CAS in Marine Biology, Annamalai University, Tamil nadu	
18	An Anthology of Indian Mangroves- Publication of CAS in Marine Biology, Annamalai University, Tamil nadu	
19	Living on the edge- L.Kannan and R.Kannan-Publication of CAS in Marine Biology, Annamalai University, Tamil nadu	
20	Wave in Bay (Impact of Tsunami on coastal Resources)- Publication of CAS in Marine Biology, Annamalai University, Tamil nadu	
21	Non-Living resources from the coastal Environment- M.Srinivasan and N. Gayatri- Publication of CAS in Marine Biology, Annamalai University, Tamil nadu	
Marine Biotechnology		
1	Environmental Biotechnology, Principles and applications by Bruce E.Rittmann and Perry L. McCarthy., McGraw Hills	
Marine Ecology		
1	Marine Biology – An Ecological Approach (Fourth Edition) by J.W. Nybakken, Addison Wesley Edu. Pub. Inc., 1997	
2	An introduction to Marine Ecology (Third edition) by R.S.K. Barnes and R.N. Hughes, Blackwell Science, 1999.	
3	Basic Ecology by E.P. Odum, Saunders College Publications, Philadelphia, 1987	
4	Marine Ecology by J.S. Levinton, Prentice-Hall Inc., New Jersey	

5	Environmental Science – A study of interrelationships (Sixth Edition) WCB/McGraw Hill, 1995.	
6	Estuaries by Baskara Sanjeevi- Publication of CAS in Marine Biology, Annamalai University, Tamil nadu	
Marine Pollution		
1	Marine Pollution by Sebastian A. Gerlach, Springer Verlag	
2	Marine Pollution by Johnson, R., Academic Press	
3	Marine Pollution by Clarke	
Biostatistics		
1	Methods in Biostatistics by Mahajan	
2	Statistical Methods, Gupta, S.P. (1996) Sultan Chand & Sons Publications, New Delhi	
3	Fundamentals of Bio-Statistics, Khan, I.A and Kanum, A., (1994) Ukaaz Publication, Hyderabad	
Fundamentals of Environmental Science / Ecology		
1	A Text Book of Environment, Agarwal, K.M., Sikdar, P.K and Deb.S.C (2002), Mac Millan India Ltd, Kolkatta	
2	Fundamental and Environmental Ecology, III Edition, (1971) Odum, E.P., Prentice Hall	
Environmental Pollution		
1	Encyclopedia of Environmental Pollution and Control, Trivedy,R.K (1994) Enviromedia Publications, Karad	
Environmental toxicology		
1	Introduction to Environmental Toxicology: Impacts of chemicals upon Ecological systems: Landis, Wayne and Hing-hoYu, Baca Raton, 1995. Lewis Publishers	
Instrumentation and analysis		
1	Instrumental Methods of Chemical Analysis, B.K. Sharma, (2001) Goal Publishing House, Meerut., India	
1	Standard Methods for the Examination of Water and Wastewater, (1998) 20th (Ed.) APHA,Washington, D.C.	
Environmental Management		
1	Environmental Management in Pactice,Volume – I to III Instruments for Environmental Management, Nath,B., Hens,L., Compton, P and D.Devuyst (1998), Routledge, London and New York	
Biodiversity		
1	Global Biodiversity – Status of the Earths Living Resources, Brian Groombridge (1992) Chapman & Hall, London	
Environmental Impact Assessment		
1	Environmental Impact Assessment, Canter,L.W., (1996) Mc Graw Hill, New York	
Environmental Microbiology and Bioremediation		
1	Bioremediation – Principles, Eweis,J.B., Ergas,S.J, Change,D.P.Y and Schroeder, E.D (1998) Mc Graw-Hill Inc	
Remote sensing		
1	Introduction to Environmental Remote Sensing, Barrett, E.C and Curtis, L.F (1982)	
2	Fundamentals of Remote Sensing, George Joseph (2003), Universities Press (India) Ltd., Hyderguda, Hydrabad	
Industrial safety		
1	Environmental and Industrial Safety, Hommadi, A. H. (1989). I.B.B Publication, New Delhi	

Krantiguru Shyamji Krishna Verma

Kachchh University

Mundra Road

BHUJ : 370 001

SYLLABUS (CBCS)

B. Sc. Semester III & IV

Marine Science and Environmental Science

With effect from June 2012

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