DEPARTMENT OF MARINE LIVING RESOURCES

Revised Syllabus

With effect from 2021-2022

ANDHRA UNIVERSITY
Visakhapatnam

DEPARTMENT OF MARINE LIVING RESOURCES, ANDHRA UNIVERSITY
M.Sc. Marine Biology and Fisheries-I Semester- Scheme of Examination
(With effect from 2021-2022 admitted batches)

Paper No	Paper Title	Maximum Marks			Credits		
		Theory (End exam + Mid)	Practical (Semester end)	Total marks	Theory	Practical	Total
1.1	Physical and Chemical Oceanography	80+20	50	150	4	2	6
1.2	Biological Oceanography	80+20	50	150	4	2	6
1.3	Marine Ecology	80+20	50	150	4	2	6
1.4	Biostatistics	80+20	50	150	4	2	6
	Total marks	**400**	**200**	**600**	**16**	**8**	**24**
M.Sc. Marine Biology and Fisheries-II Semester							
		Theory (End exam + Mid)	Practical (Semester end)	Total marks	Theory	Practical	Total
2.1	Estuaries and Coastal Zone Management	80+20	50	150	4	2	6
2.2	Biology of Marine Organisms	80+20	50	150	4	2	6
2.3	Fish Physiology	80+20	50	150	4	2	6
2.4	Fishery Science	80+20	50	150	4	2	6
	Total marks	**400**	**200**	**600**	**16**	**8**	**24**
M.Sc. Marine Biology and Fisheries-III Semester							
		Theory (End exam + Mid)	Practical (Semester end)	Total marks	Theory	Practical	Total
3.1	Fishing Technology and Fishery Management	80+20	50	150	4	2	6
3.2	Aquaculture	80+20	50	150	4	2	6
3.3	Fish Nutrition and Feed Technology	80+20	50	150	4	2	6
3.4	Marine Pollution & Bio-deterioration	80+20	50	150	4	2	6
3.5	**MOOC-I**						4
	IPR (Value added course)						
	Total marks	**400**	**200**	**600**	**16**	**8**	**28**
M.Sc. Marine Biology and Fisheries-IV Semester							
		Theory (End exam + Mid)	Practical (Semester end)	Total marks	Theory	Practical	Total
4.1	Fish Processing Technology	80+20	50	150	4	2	6
4.2	Fishery Economics and Extension	80+20	50	150	4	2	6
4.3	Aquaculture Biotechnology	80+20	50	150	4	2	6
4.4	**MOOC-II**						4
4.5	Project	100		100	4	-	4
	Viva-voce		50	50		2	2
	Research Methodology (VAC)						
	Total marks	**400**	**200**	**600**	**16**	**8**	**28**

Programme: M. Sc., Marine Biology and Fisheries

Programme Outcome (PO)

PO1. Obtain knowledge in various aspects of marine ecosystems, physical and chemical parameters, biological oceanography and biostatistics.

PO2. Acquire knowledge in various aspects of coastal zone management, biology of marine organisms, fish physiology and fisheries science,

PO3. Obtain knowledge in fishing technology and fishery management, aquaculture, fish nutrition and feed technology, coastal marine pollution and bio-deterioration.

PO4. Acquire knowledge of fish processing and preservation, fishery economics and extension, application of biotechnology to aquaculture for best culture production of food species.

PO5. Skilled, technical manpower will be produced to serve the fisheries sector, aquaculture sector, marine fisheries and aquaculture research institutes and to the colleges to teach marine biology and fisheries courses.

Programme Specific Outcome:

PSO1. The student will get a thorough knowledge in the area of marine biology, marine pollution, fisheries science and fisheries management.

PSO2. The student will be equipped with the knowledge and technical strength to undertake entrepreneurship in both capture and culture fisheries.

PSO3. The student will be able to start NGOs to protect the coastal ocean against release of pollutants, to protect endangered marine organisms, coral reef and mangrove ecosystems.

Programme Educational Objectives (PEO):

PEO1. To get employment in fisheries sector, aquaculture sector, marine fisheries and aquaculture research institutes and become an entrepreneur and to the colleges to teach marine biology and fisheries courses.

PEO2. Pursue the higher studies in India and Abroad.

M.Sc. Marine Biology and Fisheries

First Semester

Course: 1.1: Physical and Chemical Oceanography

Learning Objectives (LO)

LO1. The student will be given knowledge on physical, chemical parameters of sea water, currents, circulation patterns, nutrients and gases distribution and their importance in the fisheries production which helps the student understand importance of the physical and chemical properties seawater, the role of the oceans in keeping the continental climate cool.

LO2. The student shall learns about the methods such as Determination of salinity by Harvey's and Knudsen's method
Determination of Dissolved Oxygen by Winkler's method
Determination of pH by pH meter method
Determination of alkalinity by titrimetric method

LO3. Calculation of tide time and tide height

LO4. Calculation of density of sea water using salinity and temperature data, Upwelling/sinking phenomena, identification of water mass, determining the stability of water column using temperature and salinity data.

LO5. The student shall be given knowledge of how to operate the equipment such as, Nansen's water bottle, Niskin's water bottle, Secchi disc, Refractometer, Reversing thermometer while working 'on board'.

Course Outcome:

CO1. The student will get sound knowledge on the physical, chemical parameters of sea water, currents, circulation patterns, nutrients and gases distribution and their importance in the fisheries production.

CO2. The student understands importance of the physical and chemical properties seawater, the role of the oceans in keeping the continental climate cool.

CO3. The student will get knowledge on the role played by the various properties of seawater on the sustainability of organisms and on the overall productivity of oceans.

CO4. The student will be aware of the various marine research institutions in India and abroad to prepare himself to seek a position in the institute or to pursue higher studies.

Course Specific Outcome

CSO1. The student will be able to understand the reasons for climatic changes in day to day life.

CSO2. The student will have an opportunity to work in the organizations such as NRSA, INCOIS, NIO, IMD as technical person.

Unit -I

Dimensions of Oceans, Physical parameters of sea: Temperature, light, waves, currents, upwelling &sinking, density & pressures, tides, sound and its propagation in the sea. Upwelling and Sinking, Heat budget of oceans. Global circulation patterns.
The sea as a suitable physical, chemical and biological environment.

Unit - II

Constancy of composition of sea water- salinity, chlorinity, definition and significance. Conservative behaviour of major elements, interaction of trace elements with marine organisms, factors affecting the distribution of trace elements in the sea.
Dissolved gases in sea water- basic concepts: Solubility of gases in sea water, air-sea gas exchange, processes affecting their distribution.

Unit-III

Dissolved oxygen in the oceans: Distribution & factors affecting its distribution
Carbon dioxide system: Co_2 equilibrium in the sea water, pH, alkalinity & buffering capacity of sea water, Calcium carbonate precipitation & dissolution phenomenon - its biological importance.

Unit - IV

Micro nutrient elements: N, P, Si in sea water - their forms in sea water, distribution & cycles. N:P ratios, uptake & regeneration of nutrient elements.
Chemistry of sea surface micro-layer - origin, thickness and collection of surface material, propertiesof the sea surface micro-layer.

Unit - IV

National and International Institutes of marine research.
NIO, CMFRI, CIFE, CIFT, CIBA, MPEDA, INCOIS, NRSA., their affiliation, thrust areas of research, administration hierarchy, scientist recruitment.
Scripp's Institute of oceanography, Woods Hole Institute of Oceanography, Rosential School of Marine Sciences, Hawaiian Institute of Marine Biology, National Oceanography and atmospheric administration, Plymouth Laboratories.

References:

Riley, JP and Chester R	Introduction to marine chemistry	Academic Press
Riley JP and Skirrow, G	Chemical Oceanography (Vol.1,2,3 &8)	Academic Press
R.A.Wiley	Sea water: Its composition, properties & behaviour	The open University
Broecker and Peng,	Traces in the Sea Lamont-Dohery Geological Observatory, NY	
M.E.Q. Pilson	An introduction to the chemistry of the Sea	Cambridge Uni. Press
Burton *et al.*,	Dynamic processes in the chemistry of the upper ocean	Plenum Press
D. Satyanarayana	Introduction to marine chemistry.	

Practical:

1. Determination of salinity by Harvey's and Kneudson's method
2. Determination of Dissolved Oxygen by titrimetric method
3. Determination of pH by pH meter method
4. Determination of alkalinity by titrimetric method
5. Calculation of tide time and tide height
6. Calculation of density of sea water using salinity and temperature data
7. Identifying the resulting phenomenon (Upwelling/sinking) by observing the vertical temperature cross-section data of a given layer of water column
8. Identification of water mass, determination of stability of water column using temperature and salinity data
9. Equipment : Nansens' water bottle, Niskin's water bottle, Secchi disc, Refractosalinometer, Reversing thermometer

Course: 1.1. Mapping of course outcome with programme outcome

	CO1	CO2	CO3	CO4	CO5	CO6
PO1	✓	✓	✓	✓	✓	✓
PO2						
PO3						
PO4						
PO5						
PO6						

Course: 1.2: Biological Oceanography

Learning Objectives (LO):

LO1: To study the distribution and collection methods of plankton in the marine environments.
LO2: To study the instruments for collection of plankton and the methods of fixation of plankton.
LO3: To study the distribution of plankton.
LO4: To study the productivity of plankton .
LO5: To study the marine food chains.

Course Outcome (CO):

CO1**:** Gets knowledge on **i**dentification of plankton
CO2: Gets knowledge on various instruments for collection of plankton, various methods of fixation and preservation .
CO3: Gets knowledge on the distribution of plankton and their relationships.
CO4: Gets knowledge on the productivity of plankton in different oceans.
CO5: Gets knowledge on food chains.

Course Specific Outcome (CSO):

CSO1: Able to identify the plankton, estimate the biomass and their distribution in different oceans.
CSO2: Able to perform Oceanographic research.

Unit-1

Introduction to plankton: General classification and composition of plankton. Floating mechanismn in plankton. Collection of plankton:

Unit- II

General account of instruments and nets employed. Methods of fixation and preservation; Analyses and enumeration of samples. Standing crop estimation methods.

Unit- III

Plankton in relation to fisheries: General account. Distribution of plankton in space and time, Horizontal distribution: neretic and oceanic plankton; geographical distribution and indicator species. Vertical distribution: Vertical migrations, Seasonal changes in plankton. Phytoplankton and Zooplankton relationships.

Unit- IV

Primary and Secondary (zooplankton) production: General account of productivity in different oceans.
Factors affecting primary and secondary production: Nutrients, light, temperature, organic micro-nutrients, inhibitors and grazing. Particulate and dissolved organic matter in the sea.

Unit- V

Red tides and Mass-mortality in the seas. General survey of marine food chains: Pelagic food chains. Pelagic food pyramid and factors affecting its production & stability.

References:

Angel MV	Biological Oceanography	Methuen
Friedrich H	Marine ecology	S & J
Raymont JEG	Plankton & Productivity	Pergamon
Ekman S	Zoogeography of the sea	S & J
Parsons et al	Biological Oceanographic	Pergamon

Practical:

1. Identification of Phytoplankton: Diatoms, Flagellates, Dinoflagellates, Coccolithophores and Toxic dinoflagellates
2. Identification of Zooplankton: Holoplankton, Neroplankton, Coastal and Oceanic plankton
3. Analysis and enumeration of Phytoplankton and Zooplankton: Biomass and standing crop estimation
4. Estimation of particulate organic matter in sea water
5. Chlorophyll estimation
6. Plankton nets

Course 1.2. Mapping of Course outcome with Programme outcome

	CO1	CO2	CO3	CO4	CO5
PO1					
PO2	✓	✓	✓	✓	✓
PO3					
PO4					
PO5					

Course 1.3: Marine Ecology

Learning Objectives (LO):

The student will be given knowledge on

LO1.Various organisms of rocky shore, sandy shore and muddy shore with special reference to their ecological features, adaptations, economic importance & the larvae of marine benthic organisms.

LO2. Ecological modeling of ecosystems

LO3. Analysis of sediment composition.

LO4. Students will be taken to Field visit to rocky, sandy and muddy shores to study ecology.

LO5. Computational species diversity indices using the data collected from rocky shore/ zooplankton sample

LO6. Instruments: Cores, Grab sampler, dredge – their operational procedures to collect samples.

Course Outcome (CO):

CO1. The student will get knowledge about the various ecological zones, environmental conditions and types of organisms/ fisheries of those zones for exploitation.

CO2. The student will get the knowledge of intertidal rocky shore, sandy shore, muddy shore.

CO3. Coral reefs and mangrove ecosystems and their ecological conditions, organisms and their adaptations.

CO4. Rrecognizing the substratum by the larvae of benthic organisms for settlement; the contribution of the benthic organisms to the pelagic communities of organisms.

CO5. The student will get good understanding about the role played by marine thalloid algae in supporting the phytal fauna there by enriching the benthic and pelagic food chains, macro, micro and benthic fauna.

Course specific outcome (CSO):

CSO1.The student will be able to understand the various marine organisms useful to human beings.

CSO2.The student will have an opportunity to work in the organizations such as NIO, CMFRI, CIBA, CIFT as technical person.

Unit -I

Classification of marine environment. General characters of the primarybiotic divisions.

Distribution of shallow water benthic organisms; Fauna of deep sea and hadal regions – their adaptations.

Unit - II

Intertidal Environment: Physico-chemical parameters in the intertidal region: Insolation, desiccation. Types of rocky shores, Rock pool Environment, distribution of life on rocky shore, sandy shore and muddy shore, zonation and adaptations of organisms of rocky shore, sandy shore and muddy shore.

Unit - III

Zoogeography of seas with special reference to Indo-west Pacific region. Ecology of coral reefs and mangrove habitats; their special features. Food chains of coral reef and mangrove ecosystems**.**

Unit - IV

Larval Ecology: Types of larvae and their distribution. Chemical communications and settlement of larvae of marine benthic organisms. Ecological importance and conservation of marine algae.Ecological modelling.

Unit - V

Macro, micro and benthic fauna and their ecology, Benthic and autotrophic production, chemical composition of sediments, aerobic and anaerobic environments, animal -sediment relations.

References:

Svedrup *et al*	The Oceans	Prentice Hall
Tait RV	Elements of marine ecology	Butterworths
Riley & Skirrow	Chemical Oceanography	Academic Press
Newell RC	Biology of intertidal animals	Logos Press
Kinne O (Ed)	Marine ecology	John Wiley & Sons
Marshall NB	Aspects of Deepsea Biology	Hutchinson
Ekman S	Zoogeography of the sea.	Sidgwick & Jackson

Practical:

1. Representative organisms of rocky shore, sandy shore and muddy shore with special reference to their ecological features, adaptations, economic importance.
2. Larvae of marine benthic organisms.
3. Ecological modelling of ecosystems
4. Analysis of sediment composition analysis
5. Field visit to rocky, sandy and muddy shores.
6. Computational species diversity indices using the data collected from rocky shore/zooplankton sample
7. Instruments: Cores, Grab sampler, dredge.

Course 1.3. Mapping of Course outcome with Programme outcome

	CO1	CO2	CO3	CO4	CO5
PO1	✓	✓	✓	✓	✓
PO2					
PO3					
PO4					
PO5					

Course: 1.4: Biostatistics

Learning objectives (LO):

LO1. To understand the basics of Biostatistics, collection of sample, sampling design, collection of data and classification of data.

LO2. To understand techniques for representation of data both diagrammatically and graphically. To understand the contents and properties of measures of central tendency.

LO3. To understand the general principles of measures of dispersion, correlation and regression analysis.

LO4. To understand the estimation and testing of hypothesis through tests of significance and knowledge on types of errors.

LO5. To understand the principles of computer applications for stock assessment through various models using Microsoft Excel and also know the applications of statistics in Marine Biology and Fisheries.

Course outcomes (CO):

CO1. Able to design sampling methods for collection of sample and data and able to classify the obtained data.

CO2. Able to represent data through one dimensional and two dimensional diagrams and through histograms, frequency polygon, frequency curve and ogive curves. Able to find out the mean, median and mode for the collected data.

CO3. Able to find out the measures of dispersion for the collected data and critically analyze and interpret the results for correlation and regression.

CO4. Able to implement different tests of significance for the collected data according to the need of the problem. Able to know the types of errors.

CO5. Able to apply computer applications and statistical applications in Marine Biology and Fisheries.

Course Specific Outcomes (CSO):

CSO1. Attains the skill on basics of biostatistics and applications of statistics in Marine Biology and Fisheries.

CSO2. Becomes competent to apply computer applications in analyzing the biological data.

UNIT -I

Introduction to statistics, Sampling and sampling design, Collection of primary and secondary data, Classification and tabulation of data.

UNIT -II

Diagrammatic (one dimensional & two dimensional) representation of data. Graphical representation (Histogram, frequency polygon, frequency curve,and ogive curve) of data, Measures of central tendency (Mean, median and mode).

UNIT -III

Measures of dispersion: standard deviation, standard error, variance, Skewness, kurtosis and moments. Correlation and regression analyses, Probability and distributions.

UNIT-IV

Estimation and testing of hypotheses; Tests of significance: Z test, t test, F test, Chi-square test, ANOVA (one way and two way), ANCOVA, multi-variate analyses. Types of errors & levels of significance.

UNIT -V

Computer applications: Analyses of data using Microsoft Excel in stock assessment, use of virtual population analysis and pedigree analysis and predictive models.
Applications of statistics in marine biology and fisheries: data collection analyses.

References:

Arora & Malhan	Biostatistics	Himalaya
Ramakrishnan	Biostatistics	Saras
Gupta SC	Statistical methods	Sultan chand
Sokal & Rohlf	Biometry	Freeman
Jorgenson SE	Fundamentals of ecological modelling	Elsevier

Practical:

1) Classification of data.
2) Diagrammatic representation & Graphical representation of data.
3) Measures of central tendency.
4) Measures of dispersion.
5) Correlation analysis.
6) Probability and distribution.
7) Estimation and confidence limits.
8) Parametric tests - Z, P, and F
9) Analysis of variance.
10) Chi-square test.
11) Case study on Marine Biological data
12) Analysis of secondary data- MS Excel.

Course 1.4: Mapping outcomes (COS) with Programme outcomes (POS):

	CO1	CO2	CO3	CO4	CO5
PO1	✓	✓	✓	✓	✓
PO2					
PO3					
PO4					
PO5					

M.Sc. Marine Biology and Fisheries
Second Semester

Course 2.1: Estuaries and Coastal Zone Management

Paper 2.1: Estuaries & Coastal Zone Management

Learning Objectives (LO):

LO1. To impart knowledge to the students about different types of estuaries in India and abroad the physico-chemical properties of estuaries, salinity stratification in estuaries.

LO2. Impart knowledge on the types of animal communities and plant communities of Indian estuaries.

LO3. To make the student equip with the knowledge of coastal zone regulations and CZRs with reference to aquaculture, management of estuaries and coastal zones, applying remote sensing methods.

LO4**.** To give knowledge to the student in topics such as IUCN, criteria for categorizing animals to keep in red-list, wild life protection act, marine protected areas, sanctuaries and biosphere reserves, national marine parks.

LO4. To give knowledge in the advanced topics such as geographic information system and its applications in coastal zone management, International law of the seas.

Course Outcome (CO):

The student obtain sound knowledge

CO1. on the ecology, biodiversity and the importance of estuaries and mangroves of Indian coastal zones.

CO2. on the coastal zone regulations, IUCN criteria for listing the organisms in the red list, wild-life protection act, MPAs.

CO3. On the sanctuaries and biospheres, their role in conserving wild-life, *in-situ* and *ex-situ* conservation methods and is able to educate the public against CRZ, protecting wild life and conservation of endangered species

CO4. on the advanced topics such as GIS, remote sensing, application of those advanced topics in the management of estuaries, mangroves and coastal zones and can apply these technics whenever need arise, in his work place

CO5. Finally the student may be encouraged to initiate NGOs to protect marine and wild-life.

Course specific Outcome (CSO):

CSO1. The student will be able to understand the importance of estuaries, coastal regulatory zone

CSO2. The student will get appointment in the organizations such as sanctuaries, biospheres as technical person.

CSO3. The student can work with NGOs of wild life protection, conservation

Unit – I

Classification of estuaries: Types of estuaries

Estuarine environment: Physico-chemical properties of estuaries

Salinity stratification in estuaries

Unit – II

Distribution of estuarine plankton, nekton and benthos – their adaptations to estuarine life. Estuarine plants:

Distribution of mangroves. Estuarine birds and estuarine food web.

Unit- III

Coastal Zone Management: Coastal resources: finfish, shellfish, non-living Resources and their management.

Coastal Zone Regulations in the context of aquaculture, suitability, ICZM and estuarine management. Remote sensing applications in coastal zone management.

Unit - IV

IUCN criteria- Red list, wild life protection act, international treaties and conventions. Marine protected areas, Sanctuaries and biosphere reserves, Establishment of National Marine parks. Insitu and exsitu conservation.

Unit - V

Elements of Geographic Information System and its applications in aquaculture.

Law of the Seas. International law of the seas, Historical perspectives, International negotiations and settlements over open seas, conflict management, sharing stocks.

References:

Mc Lusky DS	Ecology of estuaries	Hinmann
Green J	Biology of estuarine animals	S & J
Carter RWG	Coastal environments	Academic Press
Kinne O	Marine Ecology	John Wiley
D.K.Pandey, H.K.De	Fisheries governance & Legislation In India	NPH

Practical:

1. Determination of sediment organic matter
2. Grain size analysis of estuarine sediment using ro-tap sieve shaker
3. Species diversity and ecological modelling of mangrove and estuarine organisms
4. Separation of total suspended matter and plotting with respect to location and tide
5. Typical estuarine and mangrove organisms.

Course 2.1: Mapping outcomes (COS) with Programme outcomes (POS):

	CO1	CO2	CO3	CO4	CO5
PO1					
PO2	✓	✓	✓	✓	✓
PO3					
PO4					
PO5					

Course 2.2: Biology of Marine Organisms

Learning Objectives (LO):

LO1. To impart knowledge on marine animal association, mechanism of feeding, digestion and excretion.
LO2. To understand the mechanism of respiration and osmoregulation.
LO3. To understand the pigments, bioluminescence, luminescent grand and organs in marine animals.
LO4. To understand the biological blocks, lunar periodicity and sense organs.
LO5. To impart knowledge on reproduction and reproductive cycles in marine animals.

Course Outcome (CO):

CO1. Acquire knowledge on marine animal association, mechanism of feeding, digestion and excretion.
CO2. Gain knowledge on the mechanism of respiration and osmoregulation.
CO3. Acquire knowledge on pigments, bioluminescence, luminescent grand and organs in marine animals.
CO4. Gain knowledge on biological blocks, lunar periodicity and sense organs.
CO5. Acquire knowledge on reproduction and reproductive cycles in marine animals.

Course specific outcome(CSO):

CSO1. The student will be able to understand the various marine organisms and their biology, seasons of abundance, reproductive seasons of marine organisms useful as food to human beings.
CSO2. The student will have an opportunity to work in the organizations such as NIO, CMFRI, CIBA, CIFT as technical person and scientist to work as Scientist.
CSO3. The student will be motivated to take up higher studies.

Unit -1

Marine animal associations: Commensalism, mutualism, Symbiosis, Parasitism andPredator – prey relationships.
Nutrition: Types of food, general mechanisms of feeding, digestion and digestive enzymes.Excretion: Mode of nitrogen excretion and elimination of nitrogenous wastes.

Unit - II

Respiration: Respiratory mechanisms; factors affecting respiration (Salinity, temperature andoxygen tension); Respiratory pigments and their role in transport of gases.
Osmotic regulation and ion regulation: General account and mechanisms.

Unit - III

General survey of pigments and colour in marine animals; Colour changes-Chromatophores; Bioluminescence: luminescent glands and organs; biochemistry of production of light,biological significance.

Unit - IV

Endogenous rhythms: Biological clocks; Lunar periodicity Physiology of sense organs: types of organs and functions.Physiology of nervous system: structure and functions.

Unit - V

General account of reproduction in marine animals: Asexual , hermaphroditism, protandry and protogyny and sex reversal.
Reproductive cycles: maturation and spawning, semalparity, iteroparity. Periodicity of maturation. Factors influencing reproduction.

References:

Nicol JAC	The Biology of marine animals	Pitman
Prosser CL	Comparative animal physiology	Saunders
Barnes RD	Invertebrate zoology	Saunders
Newell RC	Biology of intertidal animals	Logos press
Newell RC (Ed)	Adaptation to environment	Butterworth
Palmer JD	Biological clocks in mar. organisms	Wiley Eastern

Practical:

1. Dissection and display of digestive systems of Herbivorous, and Carnivorous Omnivorous shellfish and fin fish.
2. Dissection and display of reproductive system of fish, shrimp, sepia/loligo, cellana, squilla - Dissection
3. Mounting of radula of cellana, nerita
4. Mounting of gills of carnivore and herbivore fishes
5. Determination of gonadal stages and Gonadosomatic Index of fish and shell fish
6. Mouth parts and appendages of shrimp and crab.

Course 2.2: Mapping outcomes (COS) with Programme outcomes (POS):

	CO1	CO2	CO3	CO4	CO5
PO1					
PO2	✓	✓	✓	✓	✓
PO3					
PO4					
PO5					

Course: 2.3: Fish Physiology

Learning objectives (LO):

LO1. To understand the general principles of digestion, absorption and assimilation of carbohydrates, proteins & lipids and the role of hormones in the regulation of digestion.
LO2. To understand definition of respiration, types of respiratory organs, respiratory pigments, metabolism and energy budget in respiration.
LO3. To understand the cardiovascular system o fish.
LO4. To understand the reproductive physiology of fish.
LO5. To understand about neuro-hormones, endocrine glands of finfish and shellfish, their role in regulation of reproduction, moulting and growth.

Course outcomes (CO):

CO1. Able to understand the metabolism of carbohydrates, proteins & lipids and the digestive enzymes and their regulation.
CO2. Able to understand the process of respiration in fish, energy budget and expenditure.
CO3. Able to know the structure and function of heart, composition of blood and structure of blood & haemolymph pigments.
CO4. Able to know the structure and functions of gonads in fish, their development and the processes like oogenesis, spermatogenesis.
CO5. Able to attain the knowledge on neuro-hormones, different endocrine glands in fin fish and shell fish and also acquires knowledge on moulting and growth in shrimps.

Course Specific Outcomes (CSO):

CSO1. Attains the skill on basic physiology of various systems of fish and shellfish and their functions.
CSO2. Becomes competent to identify male and female fishes, identify the fishes basing on their feeding habits and also able to identify the different moult stages in shrimps.

UNIT -I

Physiology of digestion: Digestion of carbohydrates. Lipids & proteins, digestive enzymes and regulation of their secretions, absorption & assimilation of nutrients, role of hormones in the regulation of digestion.

UNIT -II

Physiology of respiration: definition of respiration, Basal Metabolic Rate (BMR), external respiration, internal respiration, types of respiratory organs, respiratory pigments & their function, respiratory metabolism, energy budget and expenditure in relation to environment conditions & stress. Chloride cells & their role in respiration.

UNIT -III

Cardiovascular system: structure and functions of heart, blood circulation, blood pressure, Composition of blood, heart and cardiac output, structure of blood/haemolymph pigments.

UNIT -IV

Reproductive physiology: development of gonads, oogenesis, spermatogenesis, metabolic changes during oogenesis & spermatogenesis.

UNIT -V

Neuro-hormones, endocrine glands of finfish and shellfish, their role in regulation of reproduction, moulting and growth.

References:

Bardach JE et al	Aquaculture	Wiley Interscience
Conn & Stump	Outlines of Biochemistry	Wiley Eastern
Halver JE	Fish nutrition	Academic press
Hoar & Randall	Fish physiology (Vol.1-12)	Academic Press

Practical:

1. Dissect and display of respiratory, circulatory, reproductive and endocrine systems in shellfish and finfish.
2. Estimation of amylase, protease, lipase, P^H in different parts of GI tract.
3. Extraction & purification of tissue protein and lipids,
4. Estimation of blood glucose, albumin and globulin, Oxygen consumption by fish/shrimp – in relation to pH, temperature and salinity,
5. Histological observations of gonads- shellfish and finfish.
6. Estimation of total protein, lipid profile, creatinine, urea and enzymes in blood.

Mapping of course outcomes (COS) with Programme outcomes (POS)

	CO1	**CO2**	**CO3**	**CO4**	**CO5**
PO1					
PO2	✓	✓	✓	✓	✓
PO3					
PO4					
PO5				✓	✓

Course 2.4: Fishery Science

Leaning Objectives (LO):
LO1. To classify the fishes and to identify economically important fishes.
LO2. To understand stock as biological entities.
LO3. To understand the population dynamics.
LO4. To understand the life cycle of fishes.
LO5. To understand migratory behaviour of fishes.

Course Outcome (CO):
CO1. Gets knowledge on **i**dentification of fishes
CO2. Gets knowledge on stock assessment.
CO3. Acquires knowledge on population dynamics.
CO4. Acquires knowledge on life cycle and on food and feeding habits of fishes.
CO5. Acquires knowledge on migratory behavior of fishes.

Course Specific Outcome (CSO):
CSO1. Student will be able to identify fishes and shell fishes up to species level.
CSO2. Gains knowledge on life cycles and breeding biology of various groups of fishes.
CSO3. Acquired knowledge on Fish migrations and Population dynamics and their importance in fishery management.

Unit – I

General account of systematic classification of fishes. Classification based on degrees of movement, zones inhabited and manner of reproduction.
Economically important groups of fishes: General and brief account of elasmobronchs, clupeoids, salmonoids, scombroids, gadoids, heterostomata, sciaenids, carangids, trichiurids, catfish, crustaceans and mollusks.

Unit – II

Natural populations or stocks as biological entities: factors limiting abundance of stocks. Criteria for distinguishing units or multi-stock species. Idea of unit stock- its relevance to tropical marine fish. Stock enhancement, strategies like introduction of exotic species, pre and post stocking management, potential risk of stocking.

Unit – III

Population dynamics: recruitment, growth and mortality.
Length-weight relationship, Condition factor. Biomass.

Unit –IV

General account of life history of Indian fishes: oil sardines, Indian shad, mackerel, Bombay duck and Malabar sole.
General account of food and feeding habits of fishes and methods of assessment.

Unit – V

Age determination of fishes. Beverton and Holt yield per recruit model, Biomass- per –recruit.
General account of movement and migration in fishes: eels, salmon, Indian shad. Marking and Tagging of fishes.

References:

Cushing DH	Fisheries biology Wisconsin	U. Press
Cushing DH	Marine ecology & Fisheries	Cambridge U. Press
Jhingran VG	Fish and fisheries of India	Hindusthan
Nelson JS	Fishes of the world	John Wiley
Royce WF	Introduction to fishery sciences	Academic Press
Peter B. Moyle, Joseph J. Cech 1990 Fishes	An Introduction to Ichthyology,	Prentice Hall**.**
Carl E. Bond	Biology of Fishes.	W.B.Saunders
Bensam, P.,	Development of Marine Fisheries Science in India.	Daya Publishing House

Practical:

1. Systematic identification of finfish and shellfish upto species level based on morphometric and meristic data
2. Gut content analysis and method of assessment of feeding
3. Estimation of fecundity
4. Length-weight relationship
5. Size at first maturity
6. Age and growth estimation
7. Relative condition factor
8. Problems related to stock assessment

Course 2.4. Mapping of Course outcome with Programme outcome

	CO1	CO2	CO3	CO4	CO5
PO1					
PO2	✓	✓	✓	✓	✓
PO3					
PO4					
PO5					

M.Sc. Marine Biology and Fisheries,
Third Semester

Course: 3.1: Fishing Technology and Fishery Management

Learning objectives (LO):

LO1. To understand the fishing crafts and gear.
LO2. To understand the methods of stock assessment
LO3. To understand the potential fishing zones
LO4. To understand the principles of fishery management.
LO5. To understand the effects of over exploitation.
LO6. To get knowledge on modern navigation equipment.

Course outcomes (CO):

CO1. Acquire knowledge on fishing crafts and gears used in India and their fabrication.
CO2. Obtain knowledge on fish stock assessment.
CO3. Acquire knowledge on identification of potential fishing zones.
CO4. Acquire knowledge on fishery management practices in India.
CO5. Gain knowledge on modern navigation equipment and their uses in marine environment.

Course Specific Outcomes (CSO):

CSO1. Student could able to conduct fishery survey and identified potential fishing zones.
CSO2. Able to monitor fishing regulations and fishery management.
CSO3. Able to get employment in fishery sector.

Unit – I

Evolution of Fishing craft: boat types and their classification. Boats used in India.
Evolution of Fishing gear: Classification of fishing gear; Descriptions of hand-line, troll line and pole line. Description, design and fabrication of trawl nets, purse-seine and gill nets.

Unit – II

Pelagic, demersal and deep sea fishing, By catch reduction in trawl fishing, Turtle Excluder Devices.
Stock assessment: Collection of basic data; stock size, yield models (Methods).

Unit – III

Fishing regulations: Potential fishing zones, code of conduct for responsible fishing, duration of fishing output control measures,

Unit – IV

Total available catch, catch quotas, licensing, technical control measures such as size limitations, closed fishing areas, closed seasons, size of nets and mesh size regulations, limited entry.

Unit – V

The effects of exploitation: The over-fishing problem, Management techniques.
Modern navigation equipment life saving devices (Buoy, jacket, raft, SART, EPIRB, SCUBA).

References:

Aitikin A Fish handling & processing
Baranov F I Selected works on fishing gear
Brandt AV Fish catching methods of the world
Cushing DH Marine ecology & fisheries
Sanisburry JC Commercial fishing methods

Practical:

1. Fishing Crafts: Catamaran, Masula boat, Dugout Canoes, Rampani and Trawler
2. Fishing Gears: Gill net, Purse Seine, Cast net, Ottor Trawl net, Beam trawl net, Hook & Line, Traps, Stake net and Dip net.

3Mess size in different fishing gears

4. Fishing gear knots: Square knot, Clove Hitch knot, Fisherman's knot
5. Fishing Gear Material: Nylon, Terylene, Polyethylene, Polypropylene
6. Other Fishing devices: Floats, Sinkers, buoy, raft
7. Length-frequency analysis of marine fishery resources
8. Gear selectivity
9. MSY-Stock recruitment relationship.

Course: 3.1. Mapping of Course outcome with Programme outcome

	CO1	CO2	CO3	CO4	CO5
PO1					
PO2					
PO3	✓	✓	✓	✓	✓
PO4					
PO5					

Course: 3.2: Aquaculture

Learning Objectives (LO):

LO1. To understand the importance and present status of aquaculture in India and Abroad

LO2. To understand various aspects of site selection and construction of fish ponds and hatcheries.

LO3. To understand various criterions for selection species for aquaculture and various culture practices.

LO4. To understand the methods of fish/shrimp seed production through hatcheries and their culture.

LO5. To understand the life cycles of sea weeds and their culture.

Course Outcome (CO):

CO1. Acquire knowledge on present status of aquaculture in Indian and Abroad.

CO2 Acquire sound knowledge on site selection and design of ponds, cages, pens and race-ways.

CO3. Obtain knowledge on selection of species for aquaculture and various culture practices.

CO4. Acquired sound knowledge on fish/shrimp hatchery management and culture of various fin fish and shellfish.

CO5. Obtain knowledge on culture of commercially important sea weeds.

Course Specific Outcome (CSO):

CSO1. Able to select suitable site and species for aquaculture.

CSO2. Able to handle the fish/shrimp hatcheries.

CSO3. Able to culture finfish, shellfish and sea weeds.

CSO4**.** Able to get employment opportunities in aquaculture and its subsidiary industries.

Unit-I

Definition and importance of aquaculture. Overview and status of aquaculture in India. Global aquaculture scenario, production, consumption and emerging trends.

Unit-II

Technical and non-technical considerations in site selection: Ecological factors- Type of land and its elevation to that of water source, soil characteristics and suitability, water supply and water quality, climatic conditions; Biological factors; Socio-economic factors; Legal regulations.

Design & construction of ponds, cages, pens, racks, rafts and long lines.

Unit-III

Selection of material and equipment for aquaculture.

Criteria for selection of species for aquaculture: Economical, ecological and Biological characters.

Monoculture, Polyculture, Integrated aquaculture, Integrated multi-trophic aquaculture, Sewage fed farming, Recirculating Aquaculture Systems, Organic farming, Biofloc system.

Unit-IV

Seed production through finfish and shellfish hatcheries.

Culture practices of finfish (carps, milk fish, Pompano and cobia), crustaceans (shrimps and prawns), mollusks (mussels, edible oysters and cephalopods).

Unit-V

Life cycles of seaweeds: *Ulva fasciata, Gracilaria corticata* and *Sargassum tenerrimum.* Culture practices of seaweeds in India and Abroad. Farming of Agar, Algin and Carrageenan yielding seaweeds. Breed improvement in Sea weeds.

References:

Bardach JE et al	Aquaculture	Wiley Interscience
Pillay & Dill	Advances in aquaculture	FAO
Stickney RR	Principles of Warm water aquaculture	Wiley Interscience
Pillay TVR	Aquaculture: principles & practices	FNB
Alilis AE	Fish and shellfish pathology	Academic Press
Milne PH	Fish & shellfish farming in coastal waters	FNB
Stickney RR	Principles of aquaculture	Wiley & sons
Imai T	Aquaculture in shallow seas	Amerind

Practical:

1. Design and construction of shrimp hatchery
2. Design and construction of fish farm
3. Aquaculture equipment:
   Nets (Cast net, Scissor net), Sand filters, FRP-tanks, Harvesting buckets, Secchi disc, P^H meter, Refrectometer, Spectrophotometer)
4. General calculations in Aquaculture management:
   Survival Rate, Specific growth rate, Quantifying the seed for transport, Calculation of amount of soil required for construction of dike.
5. Identification of Cultivable finfish, Shellfish and Sea weeds.
6. Identification of Predators, weed fishes, aquatic weeds and larval forms.
7. Fertilizers used in aquaculture.

Course: 3.2. Mapping of Course outcome with Programme outcome

	CO1	CO2	CO3	CO4	CO5
PO1					
PO2					
PO3	✓	✓	✓	✓	✓
PO4					
PO5					

Course 3.3: Fish Nutrition and Feed Technology

Learning Objectives (LO):
LO1: To study the nutritional requirements of fish and shellfish.
LO2: To study the nutritional bioenergetics of fish.
LO3: To study the nutritional pathology
LO4: To study the feed requirements and feed preparations.
LO5: to analyze feed formulation and feeding practices.

Course Outcome (CO):
CO1: Gets knowledge on the composition of various feeds of finfish and shell fish.
CO2: Gets knowledge on the bioenergetics of fish and shellfish
CO3: Gets knowledge on nutritional metabolites and various nutritional deficiencies.
CO4: Gets knowledge on various feed resources and preparation of feeds.
CO5: Gets knowledge on feeding practices .

Course Specific Outcome (CSO):
CSO1: The student will be able to perform biochemical analysis of fish and feeds.
CSO2: The student gets knowledge on preparation aquaculture feeds.

Unit - I

Fish nutrition: principles of fish nutrition and terminologies, nutritional requirements of cultivable finfish and shellfish: larvae, juveniles and adults
Nutritional biochemistry: classification, structure, quality evaluation of proteins, lipids, carbohydrates, vitamins and minerals.

Unit – II

Nutritional bioenergetics: fish as an open thermodynamic system, energy requirement of fishes, digestible energy , nitrogen balance index , protein sparing effect, optimal foraging theory, mathematical modeling of ingestion, metabolic rate, energy budgets, reproductive energetics in fish and shellfish.

Unit – III

Nutritional pathology: Anti nutritional factors and anti-metabolites, microbial toxins, methods of elimination, nutrient deficiency and symptoms.

Unit – IV

Feed Resources: Nutritional value of feed ingredients, feed additives (attractants, growth stimulants, probiotics and binders), high energy feeds, isocaloric diets.
Feed Manufacture: Feed formulation and processing, On-farm feed manufacture, Commercial feed manufacture, Feed storage

Unit –V

Feeding Practices: Supplementary feed–theory and practice, complete diet - theory and practice, Feeding methods and scheduling, ration size, feed performance.

References:

S. Athithan Practical book on fish nutrition and feed technology
Cyrino EP & bureau D & Kapoor BG Feeding & Digestive Functions in fishes
Science Publ.
De Silva SS & Anderson TA Fish Nutrition in aquaculture. Champman & Hall
Elena M. Nutrition, Physiology and Metabolism in Crustaceans. Science Publishers

Lovell RT. Nutrition and Feeding of Fishes Chapman & Hall
CIFE. 1993. *Training Manual on Culture of Live Food Organisms for Aqua Hatcheries.*
Hagiwara A, Snell TW, Lubzens E & Tamaru CS. 1997. *Live Food inAquaculture*. Proceedings of **the** Live Food and Marine Larviculture Symposium. Kluwer.
Halver JE & Hardy RW. 2002. *Fish Nutrition*. Academic Press.

Practical:

1. Quantitative analysis of protein, carbohydrate and lipid from fish feeds.
2. Different types of feeds
3. Feed formulations
4. Calculation of FCR and FCE
5. Calculation of daily ration of feed

Course 3.3. Mapping outcome with Programme outcome

	CO1	CO2	CO3	CO4	CO5
PO1					
PO2					
PO3	✓	✓	✓	✓	✓
PO4					
PO5					

Course 3.4: Marine Pollution and Bio-deterioration

Learning Objectives (LO):

LO1. To understand the sources of marine pollution. Toxicity and treatment methods.

LO2. To impart knowledge on oil pollution, thermal and radioactive pollution, solid dumping, mining and dredging operations and their effects on marine ecosystem. Treatment methods

LO3. To study the fouling and boring activities of marine organisms on marine structures, controlling of boring and fouling activities of marine organisms.

LO4.To study the strategies of global environmental methods, the role of biotechnology in mitigating the pollution and management.

LO5. To offer the students opportunity to study the environmental impact assessment-methods; enzymatic removal of hazardous organic substances biological treatment of waste water.

Course Outcome (CO):

CO1. The students will get knowledge about the various types of pollutants, their sources, transport paths, transport agents, their fate in the environment; controlling, monitoring and management methods of all those pollutants.

CO2. The students will get commendable knowledge on the recent topics such as application of biotechnology to mitigate the pollutants generated by industrial activities, to treat the pollutants; EIA methods and enzymatic removal of hazardous substances.

CO3. The knowledge acquired by the students on marine pollution may encourage them to develop, conduct and participate in the programmes against release of pollutants into the coastal environment.

CO4. The student will be aware of the hazardous effects of various pollutants released into the environment and take precautions to keep up his and his family health, which contribute to the health of the society.

CO5. The student may get appointment in the waste water management boards, pollution control boards and also teaching jobs in the higher education institutes.

Course Specific Outcome (CSO):

CSO1. The students will get jobs in the pollution control board, NGOs working on coastal ocean protection and conservation activities.

CSO2. The student will have a thorough understanding about pollutants which are hazardous to the health of humans and can keep up their health, contribute to mitigate the pollution.

CSO3.The student will be motivated to take up higher studies on pollution.

Unit - I

Sources of marine pollution: dynamics, transport paths and agents.

Composition of domestic, industrial and agricultural discharges; their fate in the marineenvironment. Toxicity and treatment methods.

Unit - II

Oil pollution: Sources, composition and its fate in marine habitats. Toxicity and treatment methods.

Thermal and radioactive pollution: sources, disposal systems of heated effluents, effects andtreatment.

Solid dumping, mining and dredging operations: their effects on marine ecosystem, managementof solid waste.

Unit - III

Bio-fouling and bio-deterioration: Biofilm formation-primary, secondary, tertiary colonizers. Effects of bio-fouling and control measures: manual, mechanical, chemical and biotechnological.

Borers: Effects and control measures.

Corrosion- definition, reactions, classification. Factors and preventive measures.

Unit - IV

Global environmental monitoring methods: status, objectives and limitations.

Monitoring strategies of marine pollution: critical pathway approach and mass balancing.

Environment Impact Assessment: Assessment of damage and problems of measuring the impact

Unit - V

Role of biotechnology in marine pollution control.. Enzymatic removal of hazardous organic substances. Wastes from fish processing units and their treatment- removal of nitrogen and phosphorus. Aquatic macrophytes in treatment of waste water.

References:

NielsenSE Tropical pollution

Kinne O Marine Ecology Vol. V John Wiley

Johnson R (Ed) Marine pollution Academic Press

Patin SA Pollution and boil.Resources of oceans Butterworths

Goldberg, E. D. 1974. The Health of the oceans, UNESCO Press. Paris.

Park, P .K, Kester D.R., J.W. Deudall and B.H Ketchum, 1983. Wastes in the Ocean. Vols. 1 to 3. Wiley Interscience Publishers, New York.

Eckenfelder WW. 2000. *Industrial Water Pollution Control*. McGraw Hill.

Gray NF. 2004. *Biology of Wastewater Treatment*. Oxford University Press.

Trivedy RK. 1998. *Advances in Wastewater Treatment Technologies*. Global Science.

Practical:

1. Determination of BOD in the polluted sea water sample.
2. Determination of nutrients in the polluted sea water sample: nitrites, nitrates, silicates, phosphates
3. Determination of toxic elements in the polluted sea water sample: ammonia, sulphide
4. Estimation of particulate organic matter in the polluted sea water sample
5. Spotters: Foulers- primary, secondary and tertiary colonizers; Borers

Course 3.4. Mapping of Course outcome with Programme outcome

	CO1	CO2	CO3	CO4	CO5
PO1					
PO2					
PO3	✓	✓	✓	✓	✓
PO4					
PO5					

M.Sc. Marine Biology and Fisheries,
Fourth Semester

Course 4.1: Fish Processing Technology

Learning Objectives (LO):

LO1: To study the various bacteria found in fresh and processed foods and their impacts.
LO2: Various methods of preservation of food products,
LO3: Different methods for curing of fish.
LO4: Different methods of freezing of fish.
LO5: By products of fishery resources and Quality control measures in sea food processing plants.

Course Outcome (CO):

CO1: To gain knowledge on the various bacteria and their isolation techniques.
CO2: To gain knowledge on different techniques employed in sea food processing plants.
CO3: Gets knowledge on different methods of fish curing.
CO4: Gets knowledge on different methods of freezing of fish.
CO5: To acquire knowledge on various methods of preparation of fishery by- products and quality control measures to be employed.

Course Specific Outcome (CSO):

CSO1: The student will acquire knowledge on microbiology of fresh and processed fish and fishery products.
CSO2: The student will acquire knowledge on the various preservation techniques of fishery products.
CSO3: The student will acquire knowledge on the various techniques and measures employed in sea food processing plants.
CSO4: The student may get employment in sea food processing plants and Microbiology labs.

Unit – 1

Microbiology of fresh and processed fish: Common bacterial pathogens in fish and fishery products-isolation and identification. Bacteria of sanitary significance.

Unit – II

Handling of fish, Spoilage of fish and shellfish: effect of temperature on fish spoilage; Containers for packaging and transportation of fish
Use of chemical preservatives and irradiation in extending shelf-life of finfish and shellfish: effects of irradiation on protein, fat & vitamin.

Unit – III

Canning: principles of canning; can shapes, canning materials; handling and preparation of fish and shellfish for canning; spoilage of canned fish; chemical and microbiological spoilage and their prevention, process value calculation.
Curing: principles and practices of salting and drying the fish; microwave vacuum drying, pickling; smoking of fish; Spoilage of cured fish.

Unit – IV

Freezing of fish: techniques of freezing; types of freezers; changes during freezing: Crystallization, nucleation, crystal growth, high pressure processing.

Protection of frozen fish: glazing and wrapping; use of anti-oxidants; Thawing of frozen fish; double freezing of fish

Unit – V

Fishery By-products: processing of low cost fish; minced meat, fish oil, fish meal, Fish sausages, isinglass, glues, fish silage, chitosan, chitin pearl essence; Alginates, agar.
Quality problem in fishery products: good manufacturing practices, HACCP
National and International standards, Food laws in India.

References:

Aitikin A Fish handling & processing
Borgstorm G Fish as food Academic press
Connell JJ Advances in fish science & technology FNB
Neha Charan Assessment of fish quality
Anon. 2001. *Food Borne Disease Handbook*. 2nd Ed. Vol. IV. *Seafood and Environmental Toxins*. Marcel Dekker.
Balachandran KK. 2001. *Post Harvest Technology of Fish and Fish Products.* Daya Publ.
Sen DP. 2005. *Advances in Fish Processing Technology*. Allied Publ.
Wheaton FW & Lawson TB. 1985. *Processing Aquatic Food Products*. John Wiley & Sons.
Windsor M & Barlow. 1981. *Introduction to Fishery Byproducts.* Fishing News (Books).

Practical:

1. Estimation of moisture content in fish and shrimp muscle.
2. Estimation of Total Plate Count (TPC) in water and fish muscle sample.
3. Identification of Gram -ve and Gram +ve bacteria using Gram staining technique.
4. Assessment of freshness of fish and shrimp by using organoleptic characters.
5. Isolation of *Bacillus* and *Clostridium* species from sea food
6. Freezing curve and determination of freezing point
7. Equipments and By-products
8. Visit to processing plant to learn the sanitary conditions to be maintained in fish preservation.

Course 4.1. Mapping of Course outcome with Programme outcome

	CO1	CO2	CO3	CO4	CO5
PO1					
PO2					
PO3					
PO4	✓	✓	✓	✓	✓
PO5					

Course 4.2: Fishery Economics and Extension

Learning objectives (LO):

LO1. To understand the general concepts of economics, and study the different factors effecting economic activity, understand how input and production of output are related and effected.

LO2. To study costs and incomes having effect on Fishery Industry, understand economic concepts of Demand and Supply and their impact on Fishery.

LO3. Importance of credit and its sources to promote fisheries. Rules and regulations effecting Fisheries.

LO4. To understand the aspects effecting Fisheries operations in Global context and making it more profitable.

LO5. To understand the role of different institutes in promoting fishery activities and development.

Course outcomes (CO):

CO1. Able to identify the economic value of Fishery industry.

CO2. Able to understand application of different economic concepts like demand, supply, cost, production, income in Fisheries.

CO3. Able to understand the Fishery aspect globally.

CO4. Able to plan and develop fishery activities.

Course Specific Outcomes (CSO):

CSO1. Attains the skill in economic aspects.

CSO2. Becomes competent in Market approach of Fisheries and growth prospects.

Unit-I

Contribution of fisheries to National Economy, Introduction to fisheries economics, Role of economic, technological, social, cultural, political and environmental factors effecting fisheries, Theories of factors of production – Factor-factor, Factor-product, Product-product relationship,

Unit-II

Factors effecting Demand and Supply, Indian marketing environment; Fishery & aquaculture marketing system; Strategies and methods for promoting fisheries development, Cost function and components in fishing effort, Income concepts- factors, BEA, CVP in fisheries, Bio-economic model of the fishery, LPP

Unit-III

Management of fisheries: Regulation of commercial fisheries, Fisheries credit and finance-NABARD, Fisheries cooperatives and Rural development, Risk and un-certainities in fisheries, Fishery resources of India, overfishing and under fishing, open access fisheries,

Unit-IV

Economics of different aquaculture systems. Factors affecting economics of aquaculture, Socio-economic issues in aquaculture development, Domestic and export marketing of fish and fish products, International trade of seafood and trade regulations-WTO, Seafood Export promotion in India-MPEDA.

Unit-V

Extension in Fisheries- Fisheries training and education in India : Training Institutes, Universities, Research Organisations, modes of extension, Interdependence between fisheries and industrial development, Natural Disasters and its coping mechanism

References:

Medwin Gale Economics in Fisheries research

Grafton QR, Kirkley J, Kpmpas T & Squire D Economics for fisheries Management

Cunningham S, Dunn MR & Whitmarsh D, 1985. Fisheries Economics. St. Martin's Press

Dunne EB, 1990. Fisheries Exonomics- An Introduction. Mansell Publ.

Shang YC, 1981. Aquaculture Economics. Westview Press.

Shyam S. Salim, RS Birada and SK. Pandey, 2005. Fisheries economics and marketing- An Introduction. CIFE

Practical:

1. Estimation of different production relationships
2. Farm business analysis- Breakeven , Cost-benefit analysis
3. Mathematical analysis of production relationship
4. Estimation of Physical and economic optimum
5. Estimation of yield gap and factor shares
6. Linear programming- variable resource programming, Variable price programming and optimization techniques.

Course 4.2. Mapping of Course outcome with Programme outcome

	CO1	CO2	CO3	CO4	CO5
PO1					
PO2					
PO3					
PO4	✓	✓	✓	✓	✓
PO5					

Course: 4.3: Aquaculture Biotechnology

Learning Objectives (LO):

LO1. To understand the induced breeding, egg incubation and larval rearing of finfish and shellfish.
LO2. To understand the principles of genetics and their applications in aquaculture.
LO3. To understand the various methods of live feed culture.
LO4. To understand the health management in aquaculture.
LO5. To understand the application of biotechnology in aquaculture.

Course Outcome (CO):

CO1. Acquire knowledge on Induced breeding technology of finfish and shellfish, cryopreservation of gametes, IN-VITRO fertilization and artificial insemination.
CO2 Acquire sound knowledge on production of hybrid varieties, polyploidy, trans generic species and sex control in aquaculture species.
CO3. Obtain knowledge on types of live feeds in aquaculture and their mass cultures.
CO4. Acquired sound knowledge on various diseases of aquaculture species, disease diagnosis and control.
CO5. Obtain knowledge on application of anti-microbial peptides, therapeutic proteins, immune-stimulants and nanotechnology in aquaculture.

Course Specific Outcome (CSO):

CSO1. Able to apply induced breeding technology for production of fish/shrimp seed.
CSO2. Able to produce hybrid varieties for aquaculture. Able to culture live feeds for aquaculture species.
CSO3. Able diagnosis and control diseases in aquaculture.
CSO4. Gets employment opportunities in aquaculture and its subsidiary industries.

Unit-I

Reproductive Biotechnology: Induced breeding, Egg incubation and Larval rearing. Synthetic hormones for induced breeding - molecular endocrinology with emphasis on use of analogues for breeding like GnRH, pheromones. Cryopreservation, IN VITRO fertilization, artificial insemination.

Unit-II

Principles of genetics: fish cytogenetics; Application of genetics in aquaculture: genetic selection, hybridization, inbreeding, cross-breeding, sex control, polyploidy and transgenesis, methods of gene transfer in fishes, screening, sites, applications. Development of disease- resistant and high quality strains.

Unit-III

Live feed: culture of commercially important micro algal species (*Chaetoceros, Skeletonema, Isochrysis, Tetraselmis, Thallassiosira, Nannochloropsis*), single cell protein from *Spirulina*, Culture of Artemia, rotifers, cladocerons, chirinomid larvae.

Unit-IV

Health Management: Viral, bacterial, fungal, parasitic, nutritional and environmental diseases of cultured fish and shellfish. DNA and RNA vaccines, molecular diagnosis of viral diseases, Dot-blot, RAPD, RFLP.

Unit-V

Biotechnological approaches for peptide synthesis. Antimicrobial peptides and their applications. therapeutic proteins. Immunostimulants. anti-oxidants, antibiotics and nutraceuticals. Application of nanotechnology in aquaculture.

References:

Halver JE Fish Nutrition Wiley Interscience
Hoar & Randall Fish physiology Academic Press
Bardach JE et al Aquaculture Wiley Interscience
Conn & Stump Outlines of biochemistry Wiley Eastern
Italy, E (Eds). 1998, New Developments in Marine Biotechnology, Plenum Pub. Corp.
Milton Fingerman and Rachakonda Nagabhushanam, 1996, Molecular Genetics of Marine Organisms, Science Pub Inc.
Y. Le Gal and H.O.Halvorson 1998, New Developments in Marine Biotechnology. Springer.

Practical:

1. Pituitary gland isolation and preparation of pituitary gland extract
2. Induced spawning - fish, shrimp, Seaurchins and bivalves
4. Live feed cultures (microalgae)
5. Determination of concentration of microalgal cells in culture flasks using haemocytometer
6. Spotters of live feed organisms:
   i. Animal live feed
   ii. Plant live
7. Numericals on inbreeding, cross breeding and polyploidy
7. PCR Demo
8. Dot- Blot Dem

Course 4.3. Mapping of course outcome with Programme outcome

	CO1	CO2	CO3	CO4	CO5
PO1					
PO2					
PO3					
PO4	✓	✓	✓	✓	✓
PO5					