UNIVERSITY OF CALCUTTA

Notification No. CSR/ 112 /18

It is notified for information of all concerned that the Syndicate in its meeting held on 06.12.2018 (vide Item No.12) approved the revised syllabus of B.Sc. (Major) course of study in "Industrial Fish & Fisheries" under CBCS, under this University, as laid down in the accompanying pamphlet.

SENATE HOUSE
KOLKATA-700073
The 26th December, 2018

(Dr. Soumitra Sarkar)
Registrar (Officiating)

UNIVERSITY OF CALCUTTA

CBCS SYLLABUS OF

INDUSTRIAL FISH & FISHERIES

2018

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THREE YEAR MAJOR
DEGREE COURSE OF STUDIES

Discipline Specific Elective 4(DSE4)-Tools & Techniques in Biology	33
Discipline Specific Elective Practical 4(DSE-4-P)- Tools & Techniques in Biology	33
5.Skill Enhancement Courses	
Skill Enhancement Course 1(SEC 1)- Pearl Culture	18
Skill Enhancement Course 2(SEC 2)-Crab Culture	23
6.Generic Elective Courses	
GE 1- Choose From the CBCS Syllabus of Zoology/ Chemistry	
GE -1-P Choose From the CBCS Syllabus of Zoology/ Chemistry	
GE 2- Choose From the CBCS Syllabus of Zoology / Chemistry	
GE -2-P Choose From the CBCS Syllabus of Zoology/ Chemistry	
GE 3- Choose From the CBCS Syllabus of Zoology/Chemistry	
GE -3-P Choose From the CBCS Syllabus of Zoology/ Chemistry	
GE 4-Choose From the CBCS Syllabus of Zoology/Chemistry	
GE -4-P Choose From the CBCS Syllabus of Zoology/ Chemistry	

1. INTRODUCTION

The syllabus for Industrial Fish and Fisheries at undergraduate level using the Choice Based Credit system has been framed in compliance with model syllabus given by UGC. The main objective of framing this new syllabus is to give the students a holistic understanding of the subject giving substantial weightage to both the core content and techniques used in Industrial Fish and Fisheries. Keeping in mind and in tune with the changing nature of the subject, adequate emphasis has been given on new techniques and understanding of the subject. The syllabus has also been framed in such a way that the basic skills of subject are taught to the students, and everyone might not need to go for higher studies and the scope of securing a job after graduation will increase. There is wide deviation in the infrastructure, be it physical or in human resource, in the form of teachers' expertise and ability and aspiration of the students. Hence, University is free to choose the Electives as per their infrastructural strengths and offer at least 6 to 7 electives While the syllabus is in compliance with UGC model curriculum, it is necessary that Industrial Fish and Fisheries students should learn "Immunology" along with" Fish pathology" as one of the core courses rather than as elective. Also, an important discipline specific elective on "Fishery Microbiology" has been added. Project Work may be introduced instead of the 4th Elective with a credit of 6 split into 2+4, where 2 credits will be for continuous evaluation and 4 credits reserved for the merit of the dissertation.

2. SCHEME FOR CBCS CURRICULUM (CREDIT DISTRIBUTION ACROSS COURSES)

Course Type	Number of Courses	Credits		
		Theory	Practical	Theory+ Practical
Core Courses	14	14x4=56	14x2=28	84
Discipline specific Electives	4	4x4=16	4x2=8	24
Generic Elective	4	4x4=16	4x2=8	24
Ability Enhancement Course	2	2x2=4		4
Skill Enhancement Courses	2	2x2=4		4
Totals	26	96	44	140

3. SCHEME FOR CBCS CURRICULUM (Courses at a glance under semester)

3 A. COMPULSORY CORE COURSES

Compulsory Courses			
Fish Taxonomy	Capture Fisheries	Fish Biology	Fresh Water Aquaculture
Fish Genetic Engineering & Molecular Biology	Fish Seed production technology	Brackish water aquaculture & Mariculture	Aquarium Fisheries
Fish pathology & Immunology	Fishing craft and gear Technology	Fisheries Post Harvest Technology	Fundamental of Biochemistry
Aquatic ecology	Fisheries Extension, Fisheries economics, Marketing		

3B. DISCIPLINE SPECIFIC ELECTIVES

Discipline Specific Elective-4	
1. Fishery Microbiology	2. Entrepreneurship development
3. Biostatistics, Computer application, Remote sensing & GIS	4. Tools & Techniques in Biology

3 C. SKILL ENHANCEMENT COURSES

Skill Enhancement Courses-2	
1. Pearl Culture	2. Crab culture

3 D. GENERIC ELECTIVE COURSES

Generic Elective Courses-4	
1. GE1-Zoology/ Chemistry	2. GE2-Zoology/ Chemistry
3.GE3- Zoology/ Chemistry	4. GE4-Zoology/ Chemistry

SEMESTER WISE DISTRIBUTION OF COURSES

Semester	Course Name	Course Detail	Credit
Part-I: Semester I	Ability Enhancement Compulsory Course-I	English Communication/ Bengali	2
	Core course-1 (CC1)	Fish Taxonomy(CC1)	4
	Core course-1 Practical(CC-1-P)	Fish Taxonomy Lab(CC- 1-P)	2
	Core course-2(CC2)	Capture Fisheries(CC2)	4
	Core course-2 Practical(CC-2-P)	Capture Fisheries Lab(CC-2-P)	2
	Generic Elective-1(GE1)	Zoology/ Chemistry (GE 1)	4
	Generic Elective-1Practical(GE-1-P)	Zoology/ Chemistry (GE-1-P)	2
Part-I: Semester II	Ability Enhancement Compulsory course II	Environmental Science	2
	Core course 3(CC3)	Fish Biology(CC3)	4
	Core course 3 Practical(CC-3-P)	Fish Biology Lab(CC-3-P)	2
	Core course 4(CC4)	Fresh Water Aquaculture(CC4)	4
	Core course 4 Practical(CC-4-P)	Fresh Water Aquaculture Lab(CC-4-P)	2
	Generic Elective-2 (GE2)	Zoology/ Chemistry (GE-2)	4
	Generic Elective-2 Practical(GE-2-P)	Zoology/ Chemistry (GE-2-P)	2
Part-II: Semester III	Core course –(CC5)	Fish genetic engineering & Molecular Biology(CC5)	4
	Core course –5 Practical(CC-5-P)	Fish genetic engineering & Molecular Biology Lab(CC-5-P)	2
	Core course –6(CC6)	Fish seed production technology(CC6)	4
	Core course –6 Practical(CC-6-P)	Fish seed production technology Lab(CC-6-P)	2
	Core course –7(CC7)	Brackish water aquaculture & Mariculture(CC7)	4
	Core course –7 Practical(CC-7-P)	Brackish water aquaculture & Mariculture Lab(CC-7-P)	2
	Skill Enhancement Course-1(SEC1)	Pearl Culture(SEC 1)	4
	Generic Elective-3(GE3)	Zoology/ Chemistry(GE 3)	4
	Generic Elective-3 Practical(GE-3-P)	Zoology/ Chemistry (GE-3-P)	2
Part-II: Semester IV	Core course –8(CC8)	Aquarium Fisheries(CC 8)	4
	Core course –8 Practical(CC-8-P)	Aquarium Fisheries Lab(CC-8-P)	2
	Core course –9(CC9)	Fish Pathology & Immunology(CC9)	4
	Core course –9 Practical(CC-9-P)	Fish Pathology & Immunology Lab (CC-9-P)	2
	Core course –10(CC10)	Fishing Craft and Gears Technology (CT10)	4
	Core course –10 Practical(CC-10-P)	Fishing Craft and Gears Technology Lab(CC-10-P)	2
	Skill Enhancement Course-2(SEC2)	Crab culture(SEC 2)	4
	Generic Elective-4(GE4)	Zoology/ Chemistry (GE 4)	4
	Generic Elective-4 Practical(GE-4-P)	Zoology/ Chemistry (GE-4-P)	2

Part-III: Semester V	Core course –11(CC11)	Fisheries Post Harvest Technology (CC 11)	4
	Core course –11 Practical(CC-11-P)	Fisheries Post Harvest Technology Lab (CC-11-P)	2
	Core course –12(CC12)	Fundamental of Biochemistry(CC12)	4
	Core course –12 Practical(CC-12-P)	Fundamental of Biochemistry Lab (CC-12-P)	2
	Discipline Specific Elective-1 (DSE1)	Fishery Microbiology (DSE 1)	4
	Discipline Specific Elective-1 Practical(DSE-1-P)	Fishery Microbiology Lab (DSE-1-P)	2
	Discipline Specific Elective-2 (DSE2)	Entrepreneurship development (DSE 2)	4
	Discipline Specific Elective-2 Practical(DSE-2-P)	Entrepreneurship development Lab (DSE- 2-P)	2
Part-III: Semester VI	Core course –13(CC13)	Aquatic Ecology(CC13)	4
	Core course –13 Practical(CC-13-P)	Aquatic Ecology Lab(CC-13-P)	2
	Core course –14(CC14)	Fisheries economics, Fisheries Extension & Marketing (CC14)	4
	Core course –14 Practical(CC-14-P)	Fisheries economics, Fisheries Extension & Marketing Lab (CC-14-P)	2
	Discipline Specific Elective-3 (DSE3)	Biostatistics, Computer Application, Remote sensing & GIS (DSE 3)	4
	Discipline Specific Elective-3 Practical(DSE-3-P)	Biostatistics, Computer Application, Remote sensing & GIS Lab(DSE-3-P)	2
	Discipline Specific Elective-4(DSE4)	Tools & Techniques in Biology(DSE4)	4
	Discipline Specific Elective-4 Practical(DSE-4-P)	Tools & Techniques in Biology Lab (DSE-4-P)	2

PART I: SEMESTER I

ABILITY ENHANCEMENT COMPULSORY COURSE I: English Communication/Bengali

CORE COURSE-1 (CC1) FISH TAXONOMY

CREDITS 4	CLASS 50	MARKS 50

Unit 1: Systematics:
Definition, component, importance.

Unit 2:Taxonomy:
Definition, component, importance, stages of taxonomy, Zoological Nomenclature.

Unit 3. Classification:
Definition. Types of classification: phenetic, natural, phylogenetic and cladistics, evolutionary. Classification of subphylum crustacea upto subclass with example, classification of phylum mollusca upto subclass with example, classification of class chondricthyes upto order with example, classification of class actinopterygii upto order with example. Construction of phylogenetic tree of fishes.

Unit 4: Species concept:
Biological, typological & Evolutionary. Mechanism of Speciation. Subspecies and other intraspecific categories. Type concept.

Unit 5: Origin & Evolution of fishes:
Geological time scale, Origin & evolution of Chondrichthys, actinopterygii, Sarcopterigii (coelacanth &dipnoi).

[Note: Classification of Sub phylum Crustacea and Phylum Mollusca according to Ruppert & Barnes(1994) should be followed. On the other hand classification of Class chondricthyes and actinopterygii as per Nelson (2010) should be followed.]

Examination Pattern

Time: 2 Hour **Full Marks: 50**

Five objective type question of two mark each (2x5=10), two short note of five mark each (5x2=10) and three long question of ten mark each(10x3=30) to be answered.

References:

- Kapoor V.C. (2017) Theory and Practical of Animal Taxonomy diversity. Oxford & IBH Publishing Co. Pvt. Ltd.
- Simpson G.G.(2012). Principles of Animal Taxonomy. Scientific publishers (India).
- Jayaram K.C(2010). Fish Taxonomy. NPH
- Jayaram K.C(2010). Fishes of the Indian region. NPH
- Nelson J.S.(2010). Fishes of the world.
- Ruppert E.E & Barnes R.D.(1994). Invertebrate Zoology.

CORE COURSE PRACTICAL 1 (CC-1-P) FISH TAXONOMY LAB

CREDITS 2	Marks: 30

List Of Practical

1. Identification of fresh water Fish
2. Identification of brackish water fish
3. Identification of marine water fishes.
4. Identification of Prawn/Shrimp, Lobster, Bivalves, Cephalopods.
5. Laboratory Note Book

Examination Pattern

Time: 2½ Hour **Full Marks: 30**

1. Identification of three fresh water Fishes (Item No.1)5x3=15
2. Identification of one brackish/ marine water fishes (Item No.2, 3) 5x1=5
3. Identification of one Prawn/Shrimp, Lobster, Bivalves, Cephalopods (Item No.4) 5x1=5
4. Laboratory Note Book= 5

CORE COURSE-2 (CC 2) CAPTURE FISHERIES

CREDITS 4	CLASS 50	MARKS 50

Unit 1: Riverine fisheries:
Morphometric of rivers. Major river system in India: Fishing methods, representative ichthyofauna, and recent catch statistics. Problems encountered in fisheries development of major rivers.

Unit 2: Cold water fisheries:
Cold water fisheries resources of India. Ecological characters of cold water bodies of India. Representative species of fishes of cold water bodies of India. Present status, Prospect, Problems and development of cold water fisheries in India.

Unit 3: Reservoir and Lacustrine fisheries:
Definition and ecological features of reservoirs and lakes. Major reservoirs and lakes in India with emphasis on capture fisheries. Development of reservoir fisheries in India. Morphometrics of reservoirs and lake.

Unit 4: Estuarine fisheries:
Definition and classification of estuaries, capture fisheries-resident and migrant species, fishing methods, recent catch statistics. Fisheries of brackish water lake and backwaters. Problem of brakish water fishery in India.

Unit 5: Marine fishery resources in India:
Marine capture fishery resources at inshore, offshore and deep sea. EEZ, PFZ and continental shelf, maritime states in India. Biology and fisheries of Oilsardine, Hilsa, Pomfret, Bombayduck, Mackerel, ribbon fish, sole fish, eel, catfishes, prawns, lobsters, mollusks.

Examination Pattern	
Time: 2 Hour	**Full Marks: 50**
Five objective type question of two mark each (2x5=10), two short note of five mark each (5x2=10) and three long question of ten mark each(10x3=30) to be answered.	

References:

- Jhingran V.G. Fish and Fisheries of India. Hindustan Publication Corp.
- Biswas K.P. A text book of fish, fisheries and technology
- Jhingran and Sehgal. Cold water fisheries of India. Ind. Fish.Soc. of India
- Talwar and Kacker. Commercial sea fishes of India. ZSI
- Singh H.R. and Lakra W.S. Coldwater Aquaculture and Fisheries. Narendra Publishing House

CORE COURSE PRACTICAL 2 (CC-2-P) CAPTURE FISHERIES LAB

CREDITS 2	**Marks: 30**
List Of Practical:	
1. Analysis of Data, Drawing of Graphs, Charts, Histograms in relation to abundance and catch particular of fish. 2. Field visit of any places of east coast and west coast of India in respect of marine fisheries.(Compulsory) 3. Laboratory Note Book.	
Examination Pattern **Time: 2½ Hour** **Full Marks: 30** 1. Two questions from item no. 1 (10x2)=20 2. Submission of field note book: 8 3. Laboratory Note Book: 2	

PART I: SEMESTER I
GENERIC ELECTIVE 1 (GE1)
4 CREDITS; CLASS 50; MARKS 50

Choose from the CBCS syllabus of *Zoology/ Chemistry*

PART I: SEMESTER I
GENERIC ELECTIVE PRACTICAL 1 (GE-1-P)
CREDIT: 2; MARKS 30

Choose from the CBCS syllabus of *Zoology/ Chemistry*

PART I: SEMESTER II

ABILITY ENHANCEMENT COMPULSORY COURSE II: Environmental Science

CORE COURSE 3 (CC3) FISH BIOLOGY

CREDITS 4	CLASS 50	MARKS 50

Unit 1: Fin fish and Shell fish anatomy:

I. Morphology of skin, colouration, scales, mouth, jaws, teeth, fin and fin rays and their taxonomic importance.

II. Internal anatomy of a typical elasmobranch and Teleost fish: Alimentary canal and associated structure, Respiratory and accessory respiratory organs, Heart and circulatory system, Reproductive system, sense organs, Lateral line system, skeletal system.

III. Structure of Digestive system, Respiratory system, Circulatory system, excretory system, Reproductive and Endocrine system of Prawns.

IV. External Character of Prawn, Crab, Lobster, Bivalves, Gastropods and Cephalopod.

Unit 2: Fish Growth:

Isometric and allometric growth, the cube law, analysis of growth check on hard parts(Scale, otolith, vertebrae), Marking and tagging of fish for growth studies, length-weight relationship, poderal index, relative condition factor and gonadosomatic index.

Unit 3: Fish Physiology:

Physiology and osmoregulation of fish. Endocrine organs in fishes and their roles in control of reproduction in fishes. Physiology of digestion, respiration(aquatic and aerial) and vision. Bioluminescence in fishes. Physiology of electric organs in fishes. Gametogenesis and fertilization of fishes.

Unit 4: Fish Nutrition:

Food and feeding habit of fish, prawn, crab, bivalves and cephalopod.

Unit 5: Fish behavior:

Parental care of fishes. Fish Migration.

Examination Pattern

Time: 2 Hour **Full Marks: 50**

Five objective type question of two mark each (2x5=10), two short note of five mark each (5x2=10) and three long question of ten mark each(10x3=30) to be answered.

References:

- Ganguly B.A.,Sinha A.K., Adhikari S., Goswami B.C.B.(2018). Biology of Animals(Vol I& II). NCBA
- Khanna S.S.(214). Introduction to Fishes. Silver Line
- Srivastava C.B.L.(2014). Fishery Science and Indian Fisheries.

CORE COURSE PRACTICAL (CC-3-P) FISH BIOLOGY LAB

CREDITS 2	Marks: 30

List Of Practical:

1. **Major Dissection**:
   (i) Urinogenital system of Tilapia.
   (ii) Weberian ossicles of Catla.
   (iii) Afferent & Efferent arterial system of lata.
2. **Minor Dissection**:
   (i) Digestive system of Mrigal & Tilapia.
   (ii) Mounting of appendages of Prawn/Shrimp.
   (iii) Study of the different types of scales of fishes.
   (iv) Gill rackers of fishes of different feeding habit.
   (v) Pharyngeal teeth in fishes.
   (vi) Otolith of Tilapia
3. Determination of RLG and Gut content analysis/Gonado Somatic index/Condition factor/Fecundity of mrigal & tilapia.
4. Laboratory Note Book.

Examination Pattern

Time: 2½ Hour **Full Marks: 30**

1. One question from item no. 1 (15x1)=15
2. Two question from item no.2 and 3 (5x2)=10
3. Laboratory Note Book: 5

CORE COURSE 4 (CC 4) FRESHWATER AQUACULTURE

CREDITS 4	CLASS 50	MARKS 50

Unit 1: Scope and present status of aquaculture:
Principles of site selection of various kinds of fish farms- quality and productivity of water, soil characteristics and other parameters.

Unit 2: Carp Culture:
Pre -stocking, Stocking and Post stocking management of Nursery, Rearing and Stocking pond.

Unit 3: Different systems of aquaculture:
Monoculture, Polyculture, Integrated fish farming, cage culture, pen culture, raft culture, extensive, semi intensive and intensive fish culture, raceway culture, culture in re-circulatory systems-Criteria for selection of species for culture. Aquaculture diversification- Aquaponics system, Biofloc culture, IMTA and periphyton culture.

Unit 4: Sewage fed fish culture:
Selection of species, methods of culture, advantage and disadvantage.

Unit 5: Culture of Catfishes and Murrels: Culturable species, Spawning and fry production and grow out.
Unit 6: Cold water aquaculture: Culture of Trout, Mahseer and Salmon- Culture systems, Development of brood stock, Techniques of propagation, Grow out in tanks, raceways, cages and ponds.
Unit 7: Culture of Tilapias: Cultivated species of tilapia, Culture systems, Spawning and production of seed stock, Grow out and feeding.
Examination Pattern **Time: 2 Hour** **Full Marks: 50** Five objective type question of two mark each (2x5=10), two short note of five mark each (5x2=10) and three long question of ten mark each(10x3=30) to be answered.

References:

- Pillay T.V.R. and Kutty M.N. Aquaculture: Principles and Management. Willey India Pvt. Ltd
- Bardach J.E. Aquaculture. Willey
- Badapanda K.C. Aquaculture. Wiley

CORE COURSE PRACTICAL 4 (CC-4-P) FRESH WATER AQUACULTURE LAB

CREDITS 2	**Marks: 30**
List Of Practical: **1.** Analysis of water parameters(Pond water, riverine water, lake water) by titration method: D.O, Free CO_2, Total alkalinity, Total Hardness, Salinity, Organic Carbon, Nitrogen, Phosphate, Sulphate, Chloride, BOD, COD. **2.** 5 to 7 day training on Fresh water aquaculture. **3.** Submission of Laboratory Note Book.	
Examination Pattern **Time: 2½ Hour** **Full Marks: 30** 1. Two questions from the item no. 1 (10x2)=20 2. Submission of training report(Compulsory) =05 3. Submission of Laboratory Notebook= 5	

GENERIC ELECTIVE 2 (GE 2)
4 CREDITS; CLASS 50; MARKS 50
Choose from the CBCS syllabus of *Zoology/ Chemistry*

GENERIC ELECTIVE PRACTICAL 2 (GE-2-P)
CREDIT: 2; MARKS 30
Choose from the CBCS syllabus of *Zoology/ Chemistry*

PART II –SEMESTER III

CORE COURSE 5 (CC5) FISH GENETIC ENGINEERING & MOLECULAR BIOLOGY

CREDITS 4	CLASS 50	MARKS 50
Unit 1:Nucleic acids: Chemical composition of DNA and RNA; Watson and Crick Model of DNA, Secondary structure (Cloverleaf model) of tRNA.		
Unit 2:DNA Replication: Enzymes of DNA replication, Mechanism of DNA replication in Prokaryotes, prove that replication is semi-conservative. Fidelity of DNA replication.		
Unit 3: Transcription: Mechanism of Transcription in prokaryotes. transcription factors.		
Unit 4: Translation: Mechanism of translation in Prokaryotes. Genetic code, Degeneracy of the genetic code, wobble hypothesis, inhibitors of protein synthesis		
Unit 5: Post Transcriptional modifications and processing of eukaryotic RNA: Capping, splicing and polyadenylation.		
Unit 6:DNA Repair mechanism: Types of DNA repair mechanisms, nucleotide and base excision repair, SOS repair.		
Unit 7: **Molecular techniques:** PCR, Western, Southern and Northern Blot, Sanger DNA sequencing.		
Unit 8: Gene structure and Function: Gene complementation, Cistron, muton, recon,molecular recombination, gene regulation, Operon concept- lac operon.		
Unit 9:Principle of Genetic Genetic Engineering: Isolation of DNA and RNA, Recombinant DNA Technology, Cloning, Plasmids, Cosmids, Bacteriophages, Transformation and Transduction. Construction of genomic and cDNA library.		

Unit 10: Chromosomal types and composition in fish. Chromosomal manipulation in fish, Hybridization. Polyploidy, androgenesis and gynogenesis.
Unit 11: Transgenic fish production.
Unit 12: Cryopreservation of gametes.
Unit 13: Production of monosex and sterile fishes and their significance in aquaculture.
Examination Pattern **Time: 2 Hour** **Full Marks: 50** Five objective type question of two mark each (2x5=10), two short note of five mark each (5x2=10) and three long question of ten mark each(10x3=30) to be answered.

References:

- Russel P.J. iGenetics : A molecular approach.
- Allison LA. 2007. Fundamental of Molecular Biology. Blackwell Publishing. W.H.Freeman
- Lodish, B, Matsudaira, KB, Plough, A, and Martin, 2016. Molecular Cell Biology. W.H.Freeman
- Cooper GM, Hausman RE, 2009. The Cell: A molecular approach. ASM

CORE PRACTICAL 5 (CC-5-P) **FISH GENETIC ENGINEERING & MOLECULAR BIOLOGY LAB**

CREDITS 2	**Marks: 30**
List Of Practical: 1. Demonstration of polytene and lampbrush chromosome from photograph. 2. Isolation and quantification of genomic DNA using UV Spectrophotometer; Procedure /reference to be mentioned. 3. Agarose gel electrophoresis for DNA. 4. DNA isolation from fish liver. 5. Differential centrifugation of an artificially prepared mixture. 6. Histological staining of DNA & RNA in prepared slide.	
Examination Pattern **Time: 2½ Hour** **Full Marks: 30** 1. One experiment from item no. 2=10 2. One experiment from item no. 6=05 3. Two experiment from item no. 3,4,5=10 4. Laboratory note book=05	

CORE COURSE 6 (CC 6) FISH SEED PRODUCTION TECHNOLOGY

CREDITS 4	CLASS 50	MARKS 50

Unit 1: Endocrine aspect of fish reproduction:
Control of fish reproduction by brain peptide, regulation of gonadal function by pituitary gonadotrophin, endocrine control of gonadal development and maturation by steroid hormones, Histology of Pituitary, Testis and Ovary. Hormonal regulation of spermatogenesis and oogenesis. Environmental regulation of reproduction.

Unit 2: Induced Breeding of Fishes:
History of induced breeding of fishes, Methods of pituitary extract preparation, dosage determination, and injection to the brood fishes, spawning and hatching. Use of different synthetic hormones and analogues for induced spawning. Stripping and fertilization. Transport of fish seeds and brood fishes, use of anesthetics. Bundh breeding, types of bundh breeding techniques and problems of bundh breeding.

Unit 3: Hatchery Technology of fishes:
Indian Major Carps, Mahaseer and Trout hatchery. Design and function of incubators, glass jar hatchery, Chinese circular hatchery and other hatchery systems.

Unit 4: Marine fish seed production:
Sea bass, milkfish, mullets, Cobia and Silver pompano.

Unit 5: Seed production in shell fishes:
Hormonal control of reproduction. Developmental stages. Seed production and nursery rearing of *Penaeus monodon* and *Macrobrachium rosenbergii*. Various components, equipments and infrastructures facilities required.

Unit 6: Collection of fish seed from natural resources:
Riverine seed production techniques, different stages of seed: spawn, fry and fingerlings.

Unit 7: Hatchery Technology of for fishes:
Indian Major Carps, Mahseer and Trout hatchery. Design and function of incubators, glass jar hatchery, Chinese hatchery and other hatchery systems.

Examination Pattern

Time: 2 Hour **Full Marks: 50**

Five objective type question of two mark each (2x5=10), two short note of five mark each (5x2=10) and three long question of ten mark each(10x3=30) to be answered.

References:

- Jhingran VG &Pullin RSV. 1985. Hatchery Manual for the Common, Chinese and Indian Major Carps. ICLARM, Philippines.
- Jhingran VG. 1991. Fish and Fisheries of India. Hindustan Publ.
- Pillay TVR &Kutty MN. 2005. Aquaculture- Principles and Practices. Blackwell.
- Rath RK. 2000. Freshwater Aquaculture. Scientific Publ.
- Thomas PC, Rath SC &Mohapatra KD. 2003. Breeding and Seed Production of Finfish and Shellfish. Daya Publ.

CORE COURSE PRACTICAL 6 (CC-6-P) FISH SEED PRODUCTION TECHNOLOGY LAB

CREDITS 2	Marks: 30

List Of Practical:

1. Histological techniques: preparation of permanent histological slide of different organs of fishes.
2. Dissection and collection of fish pituitary gland, preservation, extract preparation, doses Determination and injection to the brood fishes.
3. Hatchery training (Fresh water fish/Brackish water fish/Aquarium fish/Prawns)
4. Laboratory Note Book.

Examination Pattern

Time: 2½ Hour Full Marks: 30

1. Staining of one histological slide, identification, drawing and labeling. 15
2. Submission of two permanent histological slides: 05
3. Collection of Pituitary gland, extract preparation and dose determination. 05
4. Hatchery training report submission and Laboratory Note Book=05

CORE COURSE 7 (CC 7) BRACKISH WATER AQUACULTURE & MARICULTURE

CREDITS 4	CLASS 50	MARKS 50

Unit 1: Introduction:
Present status of brackishwater aquaculture in India. Physicochemical parameters of brackish water. Selection of site, general planning and design of brackish water fish farms.

Unit 2: Brackishwater Finfish Culture:
Cultivable species in brackish water systems. Brackishwate fish Culture system– monoculture and polyculture. Management of Brackishwater fish pond, cages and pens- Nursery, rearing and grow out.

Unit 3: Culture of Crustacea:
Cultivable species of shrimps in brackishwater. Extensive, semi-intensive and intensive shrimp farming techniques. Lobsters culture techniques, problems and prospects in India; lobster fattening.

Unit 4: Mariculture: Open sea farming:
Scope and species cultured. Selection of site for sea farming. Different designs of open sea farming structures – construction of cages – bioengineering problems and solutions.

Unit 5: Molluscans, Echinoderms and Seaweed Culture:
Molluscan culture- edible oysters, mussels and clams culture techniques. Echinoderms culture- important species, culture techniques. Culture of seaweeds- cultivable species, culture techniques and harvesting, important seaweed products.

Unit 6: Environmental Impacts:
Environmental impact of brackish water and coastal aquaculture - Salinity intrusion, effluent discharge, eutrophication, chemical residues including antibiotics and hormones, destruction of natural habitat including paddy field and mangroves. Social issues and conflicts with other users on resources.

Examination Pattern

Time: 2 Hour **Full Marks: 50**

Five objective type question of two mark each (2x5=10), two short note of five mark each (5x2=10) and three long question of ten mark each(10x3=30) to be answered.

References:

- Pillay T.V.R. and Kutty M.N. Aquaculture: Principles and Management. Willey India Pvt. Ltd
- Bardach J.E. Aquaculture. Willey
- Badapanda K.C. Aquaculture. Wiley
- Thomas P.C. Breeding and seed production of fin fish and shellfish. Daya publishing house.

CORE COURSE PRACTICAL 7(CC-7-P) **BRACKISH WATER AQUACULTURE & MARICULTURE LAB**

CREDITS 2	**Marks: 30**

List Of Practical:

1. Analysis of water parameters(Brackish water/marine water) by titration method: D.O, Free CO_2, Total alkalinity, Total Hardness, Salinity, Organic Carbon, Nitrogen, Phosphate, Sulphate, Chloride, BOD, COD.
2. Analysis of Soil parameters: pH, Nitrate, Potassium and Organic Carbon.
3. Visit to any brackish water fish farm.
4. Laboratory Note Book.

Examination Pattern

Time: 2½ Hour **Full Marks: 30**

1. One question from item no. 1 and 2=15
2. Field Note Book: 10
3. Laboratory Note Book: 05

SKILL ENHANCEMENT COURSE 1(SEC1) PEARL CULTURE

CREDITS 2	CLASS 40	MARKS 80
Unit 1: Biology of Pearl oyster: Pearl producing molluscs. Morphology and anatomy of Pearl oyster, Life cycle of pearl oyster.		
Unit 2: Histology of mantle. Natural Process of Pearl formation. Chemical composition of Pearls. Economic importance of pearls.		
Unit 3: Pearl oyster culture: Techniques of pearl oyster culture (Fresh water and Marine water) for artificial production of pearls- Rafts, long lines, Pearls oyster baskets, under water platforms, mother oyster culture/Collection of oysters, rearing of oysters, Environmental parameters. Pearl Oyster surgery (Selection of Oyster, Graft tissue preparation, Nucleus insertion, Conditioning for surgery), Post-operative culture, harvesting of pearl, clearing of pearl.		
Unit 4: Diseases and Predators of Pearl oysters.		
Unit 5: Present status, prospects and problems of pearl industry in India.		
Examination Pattern **Time: 3 Hour** **Full Marks: 80** 10 questions of two marks each (2x10=20), 5 questions of 4 marks each(4x5=20) and 4 questions of 10 marks each (10x4=40) to be answered.		

References:

- Thomas PC, Rath SC &Mohapatra KD. 2003. Breeding and Seed Production of Finfish and Shellfish. Daya Publ.
- Southgate P. and Lucas J. 2008. The Pearl Oyster 1st Edition. Elsevier Science

GENERIC ELECTIVE 3 (GE3)
4 CREDITS; CLASS 50; MARKS 50

Choose from the CBCS syllabus of *Zoology/ Chemistry*

GENERIC ELECTIVE PRACTICAL 3 (GE-3-P)
CREDIT: 2; MARKS 30

Choose from the CBCS syllabus of *Zoology/ Chemistry*

PART II SEMESTER IV

CORE COURSE 8 (CC 8) AQUARIUM FISHERIES

CREDITS 4	CLASS 50	MARKS 50

Unit 1: Aquarium design and Construction:
Design and construction of home and public aquaria (freshwater and marine), oceanarium. Aquarium accessories - Aerators, filters (different types) and lighting. Water quality requirements.

Unit 2: Aquarium Management:
Setting up of aquarium – under gravel filter, pebbles, plants, drift wood, ornamental objects and selection of fishes, Quarantine measures. Aquarium maintenance and water quality management. Control of snail and algal growth. Handling, care, packing and transportation of fishes - Use of anesthetics. Temperature acclimation.

Unit 3: Freshwater Ornamental Fishes:
Indigenous and exotic ornamental fishes in West Bengal. Biology (maturation, secondary sexual characters, breeding habits, spawning, parental care, fertilization and development of eggs) of Gold fish, Gourami, Barbs and Tetras, Angel fish, Cichlids.

Unit 4: Freshwater aquarium plants:
Common aquarium plants, morphology and multiplication.

Unit 5: Commercial Production:
Requirements and design for the commercial production of ornamental fishes. Commercial production of goldfish, live bearers, gouramies, barbs and tetras, angel fish. Natural ponds for the mass production of ornamental fishes. Mass production of aquarium plants.

Examination Pattern

Time: 2 Hour **Full Marks: 50**

Five objective type question of two mark each (2x5=10), two short note of five mark each (5x2=10) and three long question of ten mark each(10x3=30) to be answered.

References:

- Saxena A. Aquarium Management.
- Hunnam P., Milne A., Stebbing P. The living aquarium.

CORE COURSE PRACTICAL 8 (CC-8-P) **AQUARIUM FISHERIES LAB**

CREDITS 2	**Marks: 30**
List Of Practical:	
1. Construction of a glass aquarium. **2**. Identification of aquarium fishes. **3**. Identification of aquarium plants. **4**. Laboratory Note Book.	
Examination Pattern **Time: 2½ Hour** **Full Marks: 30** **1**. Construction of a model glass aquarium: 05 **2**. Identification of 3 aquarium fishes: 5x3=15 **3.** Identification of 2 aquarium plants: 2.5x2=5 **4.** Laboratory Note Book: 05	

CORE COURSE 9 (CC9) FISH PATHOLOGY AND IMMUNOLOGY

CREDITS 4	**CLASS 50**	**MARKS 50**
Unit 1:Fin Fish Pathology: Causative agents, symptoms and control of some infectious diseases of fish- Fungal Diseases(Saprolegniasis, Branchiomycosis), Bacterial Diseases(Fin and Tail rot, Ulcer diseases, Dropsy, Eye diseases, Ferunculosis, Bacterial Gill diseases, ERM, Edwardsiellosis, Vibriosis), Protozoan Diseases(White spot diseases, Costiasis, Trichodinosis, Whirling disease), Metazoans(Dactylogyrus, Gyrodactylus, Hirodinosis, Lernaea, Argulus). Morphology, life cycle and control of fish pathogen. Viral diseases (IPN, IHN, VHs, CCVD), EUS.		
Unit 2:Shell Fish Pathology: Some common diseases of prawns – pathogens, symptoms and control- IHNV, Baculovirus, Black gill disease, brown spot disease.		
Unit 3:Immunology: Antigen and antibody, Different types of immunoglobulins. Cells and organs of immune system in fish. Innate and adaptive immunity. Humoral and Cell mediated immunity. MHC, Antigen presentation. Vaccination. Recent trend in piscine immunology.		
Examination Pattern **Time: 2 Hour** **Full Marks: 50** Five objective type question of two mark each (2x5=10), two short note of five mark each (5x2=10) and three long question of ten mark each(10x3=30) to be answered.		

References:

- Cornoy D.A, Herman R.A. Text book of fish diseases.
- Kindt T.J. and Osborne B.A., Kuby Immunology.

CORE COURSE PRACTICAL 9 (CC-9-P) FISH PATHOLOGY AND IMMUNOLOGY LAB

CREDITS 2	Marks: 30
List Of Practical:	
1. Identification of fish diseases. **2.** Identification of fish pathogen. **3.** Preparation of stained blood film to study various types of blood cells.	
Examination Pattern **Time: 2½ Hour** **Full Marks: 30** **1.** Identification of two fish diseases (5x2)=10 **2.** Identification with reasons of one fish pathogen (5x1)=05 **3.** Preparation of blood film of fishes, Differential count of WBC, drawing and labeling= 10 **4.** Laboratory note book=05	

CORE COURSE 10 (CC10) FISHING CRAFT AND GEAR TECHNOLOGY

CREDITS 4	CLASS 50	MARKS 50
Unit 1: Fishing crafts: Boat building material- wood, steel, aluminum, Ferro-cement, FRP (GRP)-advantages and disadvantages. Classification and description of different type of fishing crafts in India (inland and marine) traditional, motorized and mechanized. General arrangements of different type of fishing boats, trawlers, gill netters, purse seiners, long liners, trollers, deep sea vessels. Classification of marine corrosion.		
Unit 2: Fishing gear: Classification of fishing gear (FAO and A. Von Brandt). Fishing gear materials- natural, synthetic materials, properties and preservation, yarn numbering systems, direction of netting, type of knots, meshes, fly meshing. Mounting and webbing- different methods, hanging co-efficient. Fishing gear accessories- floats, sinkers, otter board, hook and ropes. Operation, Classification and design description of trawling, purse seining, gill netting, line fishing and squid jigging. Catch per unit effort of fishing gear.		
Unit 3: FAD's, Fish finding devices and conservation: Fish aggregating devices and artificial reefs; Impact of artificial reefs on fish stock improvement; Turtle Exclusion Devices (TED) - By-catch Reduction Devices (BRD). Fish finder, GPS navigator, sonar, net sonde, gear monitoring equipments; remote sensing.		
Unit 4: Responsible Fisheries and Fisheries Legislation: Concept of Responsible Fisheries; Monsoon trawl ban, closed season, mesh size regulations, juvenile fishing, Exclusive Economic Zone (EEZ), Coastal Regulation Zone (CRZ), Integrated Coastal Zone Management (ICZM). MSY, MEY, Over fishing, Recruitment over fishing, Aquaranching.		

Examination Pattern	
Time: 2 Hour	**Full Marks: 50**
Five objective type question of two mark each (2x5=10), two short note of five mark each (5x2=10) and three long question of ten mark each(10x3=30) to be answered.	

References:

- Biswas K.P. Advancement in fish, fisheries and technology. Narendra Publishing House.
- Badapanda K.C. Fishing Crafts and Gear technology. Narendra Publishing House.

CORE COURSE PRACTICAL 10 (CC-10-P) FISHING CRAFT AND GEAR TECHNOLOGY LAB

CREDITS 2	**Marks: 30**
List Of Practical:	
1. Identification of fishing crafts, gears, fishing accessories (floats/sinkers/hook/synthetic and natural fibres, twines, ropes, iron wares). **2**. Preparation of fishing nets. **3**. Submission of a model fishing crafts/gears. **4.** Laboratory Note Book.	
Examination Pattern **Time: 2½ Hour** **Full Marks: 30** **1**. Two Identification from the item no. 1(2x5)=10 **3.** Preparation of one fishing net/ a part/knot)=10 **4**. Laboratory Note Book=5 **5**. Submission of a model fishing craft/gear=05	

SKILL ENHANCEMENT COURSE 2(SEC2) CRAB CULTURE

CREDITS 2	CLASS 40	MARKS 80
Unit 1: Introduction: History and Present status of crab culture in India.		
Unit 2: Biology of Crabs: Economically important species of crabs. Morphology and anatomy of crabs. Sexual dimorphism, Reproductive biology & Life cycle of crabs. Habit & Habitat, Food & Feeding habits of crabs.		
Unit 3: Crabs culture: Cultivable species of crabs in India. Techniques of Crabs culture- seed production of mud crabs, crab hatchery, feeding of the larvae. Crabs fattening		
Unit 4: Prospect, problems and development of crab culture in India.		
Examination Pattern **Time: 3 Hour** **Full Marks: 80** 10 questions of two marks each (2x10=20), 5 questions of 4 marks each (4x5=20) and 4 questions of 10 marks each (10x4=40) to be answered.		

References:

- ICAR. 2006. Hand Book of Fisheries and Aquaculture. ICAR.
- Landau M. 1992. Introduction to Aquaculture. John Wiley & Sons.
- Mcvey JP. 1983. Handbook of Mariculture. CRC Press.
- Pillay TVR &Kutty MN. 2005. Aquaculture- Principles and Practices. Blackwell.
- Thomas PC, Rath SC &Mohapatra KD. 2003. Breeding and Seed Production of Finfish and Shellfish. Daya Publ.

GENERIC ELECTIVE 4 (GE4)

4 CREDITS; CLASS 50; MARKS 50

Choose from the CBCS syllabus of *Zoology/ Chemistry*

GENERIC ELECTIVE PRACTICAL 4 (GE-4-P)

CREDIT: 2; MARKS 30

Choose from the CBCS syllabus of *Zoology/ Chemistry*

PART III SEMESTER V

CORE COURSE 11 (CC11) FISHERIES POST HARVEST TECHNOLOGY

CREDITS 4	CLASS 50	MARKS 50

Unit 1:Post Harvest Technology:
Principles and importance of fish preservation. Fish sspoilage- post mortem changes and rigor mortis, post rigor spoilage. Methods of fish preservation- Icing, Freezing, Cold storage, Drying, Salting, Smoking, Canning and Fish Pickling.

Unit 2: Fish product and Byproduct:
Fish Oil, Fish liver oil, Fish meal, Fish manure, Fish flour, fish glue and isinglass.

Unit 3: Quality Assurance and Export of Fishery Products:
Quality control – basic concepts, quality and quality control. Sanitation procedures in seafood processing plants. Waste management in fish processing industries. Risk factors in seafood bio toxins, seafood pathogens, endogenous parasites. Methods of evaluating fish freshness and quality – organoleptic, physical, chemical, microbiological and instrumental methods. Quality control programmes - pre-shipment inspection, IPQC, MIPQC, HACCP and ISO Series in seafood industry. Quality standards in India and major importing countries like USA, Japan and EU. Export of fishery products from India – major countries, important products, export documents and procedures. Traceability, Quality certifications, Eco-labelling.

Examination Pattern

Time: 2 Hour **Full Marks: 50**

Five objective type question of two mark each (2x5=10), two short note of five mark each (5x2=10) and three long question of ten mark each(10x3=30) to be answered.

References:

- Biswas K.P. Fish Processing and Preservation. Daya Pub. House.
- Govindan T.K. Fish Processing Technology. Oxford & IBH Pub. Co.
- Badapanda K.C. Fish processing and preservation technology. Narendra Publishing House.

CORE COURSE PRACTICAL 11 (CC-11-P) FISHERIES POST HARVEST TECHNOLOGY

CREDITS 2	Marks: 30

List Of Practical:

1. Quality control of fishes: Crude protein analysis of fish muscle by lowry method.
2. Detection of organoleptic changes in fish.
5. Laboratory Note Book.

Examination Pattern

Time: 2½ Hour **Full Marks: 30**

1. One question from item no.1=15
2. One question from item no.2=10
3. Laboratory Note Book=05

CORE COURSE 12 (CC12) FUNDAMENTAL OF BIOCHEMISTRY

CREDITS 4	CLASS 50	MARKS 50
Unit 1: Elementary idea of structure and classification of carbohydrate, protein, lipid and amino acids. Essential amino acids and fatty acids. Significance of omega3 and omega 6 fatty acids.		
Unit 2:Carbohydrate metabolism: Process of Glycolysis, TCA cycles, Glycogenolysis, Glycogenesis, Gluconeogenesis.		
Unit 3: Elementary idea of biological oxidation, oxidative phosphorylation and electron transport chain.		
Unit 4: Lipid metabolism: Synthesis and oxidation of fatty acid.		
Unit 5: Protein Metabolism: Transamination, Deamination and urea cycle.		
Unit 6: Enzymes: Classification, Kinetics (Michelis-Menten Concept), Factors affecting enzymatic action.		
Examination Pattern **Time: 2 Hour** **Full Marks: 50** Five objective type question of two mark each (2x5=10), two short note of five mark each (5x2=10) and three long question of ten mark each(10x3=30) to be answered.		

References:

- Das D. Biochemistry. Academic publishers.
- Nelson D.L.& Cox M.M. Lehlinger Principles of Biochemistry. Mac Millan Worth Pub.
- Voet D & Voet J Biochemistry

CORE COURSE PRACTICAL 12 (CC-12-P) FUNDAMENTAL OF BIOCHEMISTRY LAB

CREDITS 2	Marks: 30
List Of Practical:	
1. Qualitative tests of functional groups in carbohydrates, proteins and lipids. Qualitative tests for carbohydrate; starch, sucrose, Maltose , fructose, glucose, protein; albumin, gelatin, peptone, fat; Test to be performed- Biuret test, Millon's test, Iodine test, Benedict's test, Barfoed test, Seliwantof's test. **2.** Paper chromatography of essential amino acids. **3.** Quantitative estimation of water soluble protein following Lowry' Methods. **4.** Laboratory Note Book.	

Examination Pattern
Time: 2½ Hour **Full Marks: 30**
1. One question from item no.1=10
2. One question from item no.2 & 3=15
3. Laboratory Note Book=05

DISCIPLINE SPECIFIC ELECTIVE (DSE 1) FISHERY MICROBIOLOGY

CREDITS 4	CLASS 50	MARKS 50

Unit 1: Introduction:
History and development of microbiology: Contributions of Louis Pasteur, Koch and Winogradsky –Diversity of microbial community – General characteristics of bacteria, fungi, viruses, algae and protozoans. .

Unit 2: Structure of microbes:
Structure of prokaryotic cell, Structure and function of bacterial cell wall, plasma membrane, capsule, flagella and endospore. Structure of fungi and yeast cell. Structure of virus. Classification of viruses. Life cycle bacteriophages - lytic and lysogenic cycle.

Unit 3: Isolation and culture of microbes:
Prokaryotic growth – characteristic features of bacterial growth curve – Effect of environmental factors on growth. Nutrition and growth of bacteria – different types of media for isolation of bacteria and fungi. Isolation and cultivation of bacteria and fungi from water and sediment. Different culture techniques.

Unit 4: Aquatic Microbiology:
Microflora of aquatic environment. Autotrophic and heterotrophic microorganisms in aquatic environment. Nutrient regeneration, role of microbes in biogeochemical cycles – Carbon, Nitrogen, Phosphorus and Sulphur cycles. Autochthonous and allochthonous microorganisms in aquatic environment.

Unit 5: Bacteria in culture pond:
Health significant bacteria in culture ponds. Culture characteristics and epidemiology of *E. coli*, pathogenic *Vibrio*, *Salmonella*, *Aeromonashydrophila*, and *Pseudomonas*.

Unit 6: Fish Microbiology:
Perishability of seafood – Microbial spoilage of fish and shell fish. Spoilage microflora. Intrinsic and extrinsic factors affecting spoilage. Microflora associated with body parts. Food borne pathogens. Sources of contamination.

Examination Pattern

Time: 2 Hour **Full Marks: 50**

Five objective type question of two mark each (2x5=10), two short note of five mark each (5x2=10) and three long question of ten mark each(10x3=30) to be answered.

References:

- Fernandes R. Microbiology Handbook: Fish and Seafood. Leatherhead Food Research Association; 2nd New edition edition

- Harry W. Seeley, Paul J. Vandemark, and John J. Lee- Microbes in Action: A Laboratory Manual of Microbiology. W. H. Freeman
- Pawar and Diganawala- General Microbiology – Vol. I and Vol. II
- Frobisher et al- Fundamentals of Microbiology

DISCIPLINE SPECIFIC ELECTIVE PRACTICAL 1 (DSE-1-P) FISHERY MICROBIOLOGY LAB

CREDITS 2	**Marks: 30**
List Of Practical:	
1. Sterilization technique- dry heating, autoclaving **2**. Media preparation. **3**. Isolation and maintenance of bacteria from fishes and water. **4**. Gram staining of bacteria. **5.** Laboratory Note Book.	
Examination Pattern **Time: 2½ Hour** **Full Marks: 30** **1**. One question from item1=5 **2.** One question from item2 and 3=10 **3.** One question from item4=10 **4.** Laboratory Note Book=05	

DISCIPLINE SPECIFIC ELECTIVE 2(DSE 2) ENTREPRENEURSHIP DEVELOPMENT

CREDITS 4	**CLASS 50**	**MARKS 50**
Unit 1:Entrepreneurship Building: 1. Meaning, Importance, Psychological, Sociological factors and distinctive competence. Entrepreneurship process. 2. Need, scope, characteristics and types of Entrepreneurship. STED. 3. Social responsibility and business ethics. 4. Human resource management, Leadership, Motivation attitude, communication, Group dynamics, Delegation, Setting of goals, Transactional analysis, Creativity, Problem solving, Strength weakness opportunity and threat (SWOT) Techniques, Decision making, Stress management.		
Unit 2:Financial Management: 1. Institutions, financing procedure and financial incentives, Banking norms as in vogue. 2. Financial ratios & and their significance, Costing and Pricing. 3. Fund flow and Cash flow concept. 4. Break even analysis		

Unit 3: Technology Management :

1. Criteria for principles of product, selection and development.
2. Choice of technology, plant and equipment.
3. Critical Path Method (CPM) & Project Evaluation Review Techniques (PERT) as planning tools for establishing SSI.
4. Quality control / quality assurance and testing of product.
5. Production Management : Elements of production process, Production Planning and control, Product development, Testing facilities, Patents, Quality Assurance, Time control and Cost control, Total Quality Management.
6. Materials Purchasing Management: Material Planning and Budgeting, Value engineering, Value analysis, Economic ordering quantity, Inventory control.

Unit 4: Marketing Management :

1. Elements of marketing & sales management.
2. Nature of product and market strategy – Packing & advertising – After sales service.
3. Touch on Import – Export procedure and methods.
4. Analyzing marketing opportunities, Planning marketing strategy, Forecasting, Marketing mix, Advertising the marketing programme & sales management, market survey techniques.

Unit 5: Project Formulation:

1. Stages and methodology in Project identification, Selection of a project format, Project report writing.
2. Analysis and evaluation of a Project report.

Unit 6: Statutory provisions:

1. Licensing, Registration – Municipal bye laws and Insurance coverage.
2. Important provisions of Factory Act, Sales of Goods Act, Partnership Act.
3. Pollution control & Environmental Act.
4. Income Tax, Sales Tax and Excise Rules.
   Business & Industrial laws, labour relations.

Unit 7: Knowledge input:

1. Industrial and economic policy declared by Government from time to time.
2. Sickness in small scale industries and their remedial measures.
3. Management Information System(MIS)

Unit 8: Data Base management:

1. Books of accounts, financial statements.

Examination Pattern

Time: 2 Hour **Full Marks: 50**

Five objective type question of two mark each (2x5=10), two short note of five mark each (5x2=10) and three long question of ten mark each(10x3=30) to be answered.

DISCIPLINE SPECIFIC ELECTIVE PRACTICAL 2 (DSE-2-P) **ENTREPRENEURSHIP DEVELOPMENT LAB**

CREDITS 2	Marks: 30
List Of Practical:	
On Job Training in any institute of fish processing technology or fish farm or any industries related with fisheries.	
Examination Pattern **Time: 2½ Hour** **Full Marks: 30** 1. Submission of on job training report= 10 2. Power point presentation/ viva =10 3. Attendance in training institute=10	

PART III SEMESTER VI

CORE COURSE 13 (CC 13) AQUATIC ECOLOGY

CREDITS 4	CLASS 50	MARKS 50
Unit 1: Introduction: Definition of Ecology and Ecosystem, Subdivision of ecology- autecology and synecology.		
Unit 2: Species and the individual in the ecosystem: Concept of habitat and ecological niche, ecological equivalents, character displacements- sympatry and allopatry, Biological clocks.		
Unit 3: Population (Structure and dynamics): Population characteristics, theories of population growth, population interactions.		
Unit 4: Community (Structure, classification and dynamics): Characteristics of community- species diversity, growth forms and structure, dominance, composition, structure. Ecological succession- definition, types of succession, general process of succession, hydrocere.		
Unit 5: Ecosystem(Structure and function): Definition, kinds of ecosystem, structure of ecosystem, ecological pyramids, productivity, food chains, food webs, energy flow in ecosystem, pond ecosystem, ocean(marine) ecosystem.		
Unit 6: Fresh water ecology: The freshwater environment, types and limiting factor, ecological classification of freshwater organism, the freshwater biota, lentic communities, lakes, ponds, lotic communities, longitudinal Zonation in streams, springs.		
Unit 7: Marine ecology: The marine environment, the marine biota, Zonation in the sea, communities of the marine environment.		
Unit 8: Estuarine ecology: Definition and types, biota and productivity.		

Unit 9: Water pollution: Sources of water pollution, Ground water pollution, marine pollution, mercury pollution, fluoride pollution, Ganga action plan(GAP), Yamuna action plan(YAP), Prevention and control of water pollution, wetland conservation.
Examination Pattern **Time: 2 Hour** **Full Marks: 50** Five objective type question of two mark each (2x5=10), two short note of five mark each (5x2=10) and three long question of ten mark each(10x3=30) to be answered.

References:

- E.P. Odum (1971) Fundamental of Ecology. W.B Sounders,
- Sharma P.D.- Ecology And Environment. Rastogi Publications

CORE COURSE PRACTICAL 13 (CC-13-P) **AQUATIC ECOLOGY LAB**

CREDITS 2	**Marks: 30**
List Of Practical:	
1. Estimation of productivity in water bodies. **2**. Collection, fixation and Identification of living phytoplankton and zooplankton from the water bodies (not by permanent slide). **3**. Laboratory Note Book.	
Examination Pattern **Time: 2½ Hour** **Full Marks: 30** 1. One question from the item no1=10 2. One question from the item no2=15 3. Laboratory Note Book=05	

CORE COURSE 14 (CC 14) FISHERIES ECONOMICS, FISHERIES EXTENSION & MARKETING

CREDITS 4	**CLASS 50**	**MARKS 50**
Unit 1: Principles of economics: Definition, subject matter and scope of economics. Law of diminishing returns, laws of increasing, constant and decreasing utility and returns. Importance of economics in aquaculture development		
Unit 2: Economy of fishermen: Fishermen populations, GDP from fisheries sector, foreign exchange earnings and employment potential of fishing industry.		

Unit 3:Prospective of Aquaculture in Socio-Economic impact & Rural Development: Resource use and development, Socio-economic analysis, Socio-demographic profile, work contribution, household expenditure, income contribution, decision making, female headed household, impact of different age groups, socio-economic condition of fisherman.
Unit 4: Marketing: Markets and their kinds. Law of demand and supply, price determination, problems of fish marketing in India. Exports of fish and fishery products, trends and problems therein. Role of MPEDA in exports of fish and fishery products.
Unit 5: Fishery co-operatives: Functions, financial assistance, input supplies, marketing of fish. Socio-economic development. Role of fisheries corporations and Missionary Organizations in fisheries development.
Unit 6: Fishery extension: Extension education- objective and principles. Role of extension in community development. Integrated rural development strategies. Programmes for weaker section of the community. Fishery development plans and various schemes
Examination Pattern **Time: 2 Hour** **Full Marks: 50** Five objective type question of two mark each (2x5=10), two short note of five mark each (5x2=10) and three long question of ten mark each(10x3=30) to be answered.

References:

- Saxena A. Fisheries Extension.
- Ry G.L. Extension, commercial and management. Naya Prakash

CORE COURSE PRACTICAL 14 (CC-14-P) **FISHERIES ECONOMICS, FISHERIES EXTENSION, MARKETING LAB**

CREDITS 2	**Marks: 30**
List Of Practical:	
1. Fish market survey. **2**. Study of socio-economic status of fishermen of any fishing villages in West Bengal. **3**. Seminar on Fisheries extension/rural economics.	
Examination Pattern **Time: 2½ Hour** **Full Marks: 30** 1. Submission of a fish market survey report or the report of socio-economic status of fishermen of any fishing villages of West Bengal =15 2. Seminar on Fisheries extension/rural economics.(Hard copy 10+ Presentation 5)=15	

DISCIPLINE SPECIFIC ELECTIVE (DSE 3) BIOSTATISTICS, COMPUTER APPLICATION, REMOTE SENSING & GIS.

CREDITS 4	CLASS 50	MARKS 50

Unit 1: Biostatistics:

Preliminary concept, definition and application of Biostatistics. Measures of Central Tendency- Mean, Median, Mode. Measures of variation-Range, mean deviation, standard deviation, coefficient of variation. Testing of hypothesis- Chi-squar test and student T-Test. Probability theory, correlation, regression.

Unit 2:Computer Application:

Introduction to computer, advantages, limitations, classification of computer, elementary idea of desktop, input-output devices-CPU, Key Board, Mouse, FD drive, CD-DVD Rom drive, RAM, Hardware and software. Office application- software: Introduction to windows, MS Word, MS-Excel and Powerpoint Presentation. Concept of Internet and its application in information collection. Basic ideas of www.

Unit 3: Remote sensing and GIS:

Definition and principle of remote sensing and GIS. Sensing mechanism. Analysis of images and data. Fisheries forecasting system in India and other countries. GPS. Application of remote sensing and GIS in fisheries conservation and management of fish faunal diversity and exploitation of capture fisheries.

Examination Pattern

Time: 2 Hour **Full Marks: 50**

Five objective type question of two mark each (2x5=10), two short note of five mark each (5x2=10) and three long question of ten mark each(10x3=30) to be answered.

References:

- B Antonisamy, Prasanna S. , Premkumar, Christopher S- Principles and Practice of Biostatistic, Elsevier India
- Rao. Biostatistics a Manual of Statistical Methods for Use in Health, Nutrition and Anthropology- Jaypee Brothers Medical Publishers; second edition
- Arora S.- Computer Applications: A Textbook. Dhanpat Rai & Co. (P) Ltd.
- Dixit P.G. and Rayarikar A.V.- Computer Applications In Statistics. Nirali Prakashan.

DECIPLINE SPECIFIC ELECTIVE PRACTICAL 3 (DSE-3-P) BIOSTATISTICS, COMPUTER APPLICATION, REMOTE SENSING & GIS LAB

CREDITS 2	Marks: 30

List Of Practical:

1. Identification of computer accessories.
2. Preparation of chart, graphs and power point presentation in computer.
3. Seminar on remote sensing (Hardcopy-5, presentation-10)

Examination Pattern
Time: 2½ Hour **Full Marks: 30**
1. One question from item no.2 =15
2. One question from item no.3=15

DISCIPLINE SPECIFIC ELECTIVE 4 (DSE4) TOOLS AND TECHNIQUES IN BIOLOGY

CREDITS 4	CLASS 50	MARKS 50
Unit 1: Microscopy: Basic principles and application of bright field, phase contrast, fluorescence and DIC microscopy.		
Unit 2: Centrifugation: Basic principles of centrifugation, Ultracentrifugation and separation of cellular organelles.		
Unit 3: Electrophoretic techniques: Vertical gel electrophoresis (native and SDS-PAGE), IEF and2-D Gel Electrophoresis.		
Unit 4: Immunological Technique: ELISA, Flow cytometry.		
Unit 5: Radioisotope Techniques: Autoradiography and Radioimmunoassay.		
Examination Pattern **Time: 2 Hour** **Full Marks: 50** Five objective type question of two mark each (2x5=10), two short note of five mark each (5x2=10) and three long question of ten mark each(10x3=30) to be answered.		

References:

- Wilson K. and Walker J. Principles and Techniques of Biochemistry and Molecular Biology

DISCIPLINE SPECIFIC ELECTIVE PRACTICAL 4 (DSE-4-P) TOOLS AND TECHNIQUES IN BIOLOGY LAB

CREDITS 2	Marks: 30
List Of Practical:	
1. Demonstration of the functioning/working of the instruments. 2. Project work/Review work.	
Examination Pattern **Time: 2½ Hour** **Full Marks: 30** 1. One question from question no.1=5 2. Submission of project/review report=15 3. Power point presentation/grand viva=10	