KERALA UNIVERSITY OF FISHERIES AND OCEAN STUDIES

SYLLABUS FOR THE B.F.Sc. COURSE UNDER FACULTY OF FISHERIES

(with effect from 2016 admission)

i) UG degree: B.F.Sc.

Sl No.	Disciplines
1.	Aquaculture
2.	Fisheries Resource Management
3.	Fish Processing Technology
4.	Aquatic Environment Management
5.	Fish Genetics and Breeding
6.	Fish Biotechnology
7.	Fish Physiology and Biochemistry
8.	Fish Health Management
9.	Fish Nutrition and Feed Technology
10.	Fisheries Extension
11.	Fisheries Economics

Restructuring of UG programmes for increased practical /practice contents

Names of Departments

Sl. No.	Departments
1.	Department of Aquaculture
2.	Department of Fisheries Resource Management
3.	Department of Fish Processing Technology
4.	Department of Aquatic Environment Management
5.	Department of Aquatic Animal Health Management
6.	Department of Fish Engineering
7.	Department of Management Studies

Department wise distribution of proposed courses

1. Department of Aquaculture

Sl. No	Course code	Course title	Credit load
1.	AQC 111	Principles of Aquaculture	2(1+1)
2	AQC 112	Fundamentals of Biochemistry	3(2+1)
3.	AQC 121	Fresh Water Aquaculture	3(2+1)
4.	AQC 122	Fish Nutrition and Feed Technology	3(2+1)
5.	AQC 123	Aquaculture in Reservoirs	2(1+0)
6.	AQC 211	Fish Food Organisms	2(1+1)
7.	AQC 212	Introduction to Biotechnology & Bioinformatics	2(1+1)
8.	AQC 221	Coastal Aquaculture and Mariculture	3(2+1)
9.	AQC 311	Finfish Hatchery Management	3(2+1)
10.	AQC 312	Shellfish Hatchery Management	3(2+1)
11.	AQC 321	Ornamental Fish Production and Management	2(1+1)
12	AQC 322	Genetics and Breeding	2(1+1)
		Total	**29 (18+11)**

2. Department of Fisheries Resource Management

Sl. No.	Course code	Course title	Credit load
1.	FRM 111	Taxonomy of Finfish	3(1+2)
2.	FRM 112	Anatomy and Biology of Finfish	3(2+1)
3.	FRM 121	Taxonomy of Shellfish	2(1+1)
4.	FRM 122	Anatomy and Biology of Shellfish	2(1+1)
5.	FRM 123	Aquatic Mammals, Reptiles and Amphibians	1(1+0)
6.	FRM 211	Physiology of Finfish and Shellfish	3(2+1)
7.	FRM 221	Marine Fisheries	3(2+1)
8.	FRM 222	Inland Fisheries	3(2+1)
9.	FRM 321	Fish Population Dynamics and Stock Assessment	3(2+1)
		Total	**23(14+9)**

3. Department of Aquatic Animal Health Management

Sl. No.	Course code	Course title	Credit load
1.	AAH 111	Fundamentals of Microbiology	3(2+1)
2.	AAH 221	Fish and Shellfish Pathology	3(2+1)
3.	AAH 222	Pharmacology	3, 2+1
4.	AAH 311	Microbial and Parasitic Diseases of Fish and Shellfish	3(2+1)
5.	AAH 312	Fish Toxicology	2(1+1)
6.	AAH 321	Fish Immunology	2(1+1)
7.	AAH 322	Therapeutics in Aquaculture	2(1+1)
		Total	**18(11+7)**

4. Department of Aquatic Environment Management

Sl. No.	Course code	Course title	Credit load
1.	AEM 111	Meteorology, Climatology and Geography	2(1+1)
2.	AEM 112	Soil and Water Chemistry	3(2+1)
3.	AEM 121	Limnology	3(2+1)
4.	AEM 122	Marine Biology	3(2+1)
5.	AEM 211	Fishery Oceanography	2(1+1)
6.	AEM 212	Aquatic Ecology, Biodiversity and Disaster Management	3(2+1)
7.	AEM 311	Coastal Zone Management	2(1+1)
8.	AEM 321	Aquatic Pollution	2(1+1)
		Total	**20(12+8)**

5. Department of Fish Processing Technology

Sl. No.	Course code	Course title	Credit load
1.	FPT 121	Fish Nutrition	1(1+0)
2.	FPT 211	Food Chemistry	3(2+1)
3.	FPT 212	Freezing Technology	2(1+1)
4.	FPT 221	Fish Canning Technology	2(1+1)
5.	FPT 222	Fish Packaging Technology	2(1+1)
6.	FPT 311	Quality assurance of Fish and Fishery Products	3, 2+1
7.	FPT 321	Fish Products and Value Addition	3(2+1)
8.	FPT 322	Microbiology of Fish and Fishery Products	3(2+1)
9.	FPT 323	Fish By-Products and Waste Utilization	2(1+1)
		Total	**21(13+8)**

6. Department of Fisheries Engineering

Sl. No	Course code	Course title	Credit load
1.	FET 211	Refrigeration and Equipment Engineering	3(2+1)
2.	FET 221	Navigation and Seamanship	2(1+1)
3.	FET 222	Fishing Gear Technology	2(1+1)
4.	FET 311	Fishing Craft Technology	2(1+1)
5.	FET 312	Aquaculture Engineering	3(2+1)
6.	FET 321	Fishing Technology	2(1+1)
		Total	**14(8+6)**

7. Department of Management Studies*

Sl. No	Course code	Course title	Credit load
1.	MGT 111	Communication Skills and personality development	1(0+1)
2.	MGT 112	Information and Communication Technology	2(1+1)
3.	MGT 121	Statistical Methods	3(2+1)
4.	MGT 211	Fisheries Co-operatives and Marketing	2(1+1)
5.	MGT 221	Fisheries Extension Education	2(1+1)
6.	MGT 311	Fisheries Economics	3(2+1)
7.	MGT 312	Fisheries Policy and Law	1(1+0)
8.	MGT 321	Fisheries Business Management and Entrepreneurship Development	1(1+0)
		Total	**15(9+6)**

***Compulsory Non-Credit Courses. At least one class per week**

1. MGT 122 Swimming 1 (0+1)
2. MGT 113 Physical Education, First Aid & Yoga Practice 1 (0+1)

Summary

Sl. No.	Department	No. of courses	Credit load
1	Aquaculture	12	**29(17+12)**
2	Fisheries Resource Management	9	**23(14+9)**
3	Department of Aquatic Animal Health Management	7	**18(11+7)**
4	Aquatic Environmental Management	8	**20(12+8)**
5	Fish Processing Technology	9	**21(13+8)**
6	Fisheries Engineering	6	**14(8+6)**
7	Management Studies	8	**15(9+6)**
8	Comp. Non-credit courses (Swimming & Phy. Edn)	2	**-**
	Sub total	**61**	**140(84+56)**
	Student READY In-Plant Attachment Programme	1	**10(0+10)**
	Student READY Rural Fisheries Work Experience Programme	1	**8(0+8)**
	Study Tour (in and outside State)	1	**2(0+2)**
	Student READY Experiential Module	1	**17(0+17)**
	Project Work	1	**2(0+2)**
	Seminar	1	**1(0+1)**
	Total	06	**40(0+40)**
	Grand Total	**67**	**180(84+96)**

SEMESTER WISE DISTRIBUTION OF COURSES

Semester I

Sl. No.	Course code	Course Title	Credit hour
1	AQC 111	Principles of Aquaculture	2, 1+1
2	AQC 112	Fundamentals of Biochemistry	3, 2+1
3	AAH 111	Fundamental of Microbiology	3, 2+1
4	FRM 111	Taxonomy of Finfish	3, 1+2
5	FRM 112	Anatomy and biology of fin fish	3, 2+1
6	AEM 111	Meteorology, Climatology and Geography	2, 1+1
7	AEM 112	Soil and Water chemistry	3, 2+1
8	MGT 111	Communication skills and personality development	1, 0+1
9	MGT 112	Information and communication technology	2, 1+1
10	MGT 113	Physical Education, First Aid and Yoga Practices	1(0+1)**CNC***
		Total	**22 (12+10)**

***CNC= Compulsory Non-credit Course.**

Semester II

Sl. No.	Course code	Course Title	Credit hour
1	AQC 121	Fresh Water Aquaculture	3, 2+1
2	AQC 122	Fish Nutrition and feed technology	3, 2+1
3	AQC 123	Aquaculture in Reservoirs	1, 1+0
4	FRM 121	Taxonomy of shell fishes	2, 1+1
5	FRM 122	Anatomy and Biology of Finfish	2, 1+1
6	FRM 123	Aquatic Mammals, Reptiles and Amphibians	1, 1+0
7	AEM 121	Limnology	3, 2+1
8	AEM 122	Marine Biology	3, 2+1
9	FPT 121	Fish in Nutrition	1, 1+0
10	MGT 121	Statistical Methods	3, 2+1
11	MGT 122	Swimming	1(0+1)**CNC***
		Total	**22(15+7)**

***CNC= Compulsory Non-credit Course.**

Semester III

Sl. No.	Course Code	Course Title	Credit hour
1	AQC 211	Fish Food organisms	2, 1+1
2	AQC 212	Introduction to Biotechnology & Bioinformatics	2, 1+1
3	FRM 211	Physiology of Finfish and Shellfish	3, 2+1
4	AEM 211	Fishery Oceanography	2, 1+1
5	AEM 212	Aquatic Ecology, Biodiversity and Disaster Management	3, 2+1
6	FPT 211	Freezing technology	2, 1+1
7	FPT 212	Food Chemistry	3, 2+1
8	FET 211	Refrigeration and Equipment Engineering	3, 2+1
9	MGT 211	Fisheries Co-operatives and Marketing	2, 1+1
		Total	**22(13+9)**

Semester IV

Sl. No.	Course code	Course Title	Credit hour
1	AQC 221	Coastal Aquaculture and Mariculture	3, 2+1
2	AAH 221	Fish and Shellfish Pathology	3, 2+1
3	AAH 222	Pharmacology	3, 2+1
4	FRM 221	Marine Fisheries	3, 2+1
5	FRM 222	Inland Fisheries	3, 2+1
6	FPT 221	Fish Canning Technology	2, 1+1
7	FPT 222	Fish Packaging Technology	2, 1+1
8	FET 221	Navigation and Seamanship	2, 1+1
9	FET 222	Fishing Gear Technology	2, 1+1
10.	MGT 221	Fisheries Extension Education	2, 1+1
		Total	**25 (15+10)**

Semester V

Sl. No.		Course Title	Credit hour
1	AQC 311	Finfish Hatchery Management	3, 2+1
2	AQC 312	Shell fish Hatcher Management	3, 2+1
3	AAH 312	Fish Toxicology	2, 1+1
4	AAH 313	Microbial and Parasitic Diseases of Fish and Shellfish	3, 2+1
5	AEM 311	Coastal Zone Management	2, 1+1
6	FET 311	Fishing Craft Technology	2, 1+1
7	FET 312	Aquaculture Engineering	3, 2+1
8	FPT 311	Quality assurance of Fish and Fishery Products	3, 2+1
9	MGT 311	Fisheries Economics	3, 2+1
10	MGT 312	Fisheries Policy and Law	1, 1+0
		Total	**25 =16+9**

Semester VI

Sl. No.	Course code	Course Title	Credit hour
1	AQC 321	Ornamental Fish Production and Management	2, 1+1
2	AQC 322	Genetics and Breeding	2, 1+1
3	AAH 321	Fish Immunology	2, 1+1
4	AAH 322	Therapeutics in Aquaculture	2, 1+1
5	FRM 321	Fish population Dynamics and Stock Assessment	3, 2+1
6	AEM 321	Aquatic Pollution	2, 1+1
7	FET 321	Fishing Technology	2, 1+1
8	FPT 321	Fish By-Products and Waste Utilization	2, 1+1
9	FPT 322	Fish Products and value addition	3, 2+1
10	FPT 323	Microbiology of fish and fishery products	3, 2+1
11	MGT 321	Fisheries Business Management and Entrepreneurship Development	1, 1+0
		Total	**24 (14+10)**

Semester VII

Sl. No.	Course Title	Credit hour
1	**Student READY Programme** a) In-plant attachment (for 8 weeks) b) Rural Fisheries Work Experience Prog. (for 8 weeks) c) Study Tour (in and outside State) (for 4 weeks)	 10 (0+10) 8(0+8) 2(0+2)
	Total	**20 (0+20)**

Semester VIII

Sl. No.	Course Title	Credit hour
1	Student READY Experiential Module (concurrent with the semester) This will include capacity building and skill development of the students in planning, development, formulation, monitoring and evaluation of project for entrepreneurial proficiency. a) Skill Development (for one week) b) Experiential Learning Programme	 5(0+5) 12(0+12)
2	Project Work	2(0+2)
3	Seminar	1(0+1)
	Total	**20(0+20)**

* Student READY Programme

Student READY Experiential Module

a) **Skill Development (for one week) :** Aquarium fabrication, Analysis of soil and water quality parameters, Preparation of Fish products or in any appropriate applied aspect of fisheries

b) **Experiential Learning Programme:**
A minimum of two areas should be decided by each university. Areas of specialization for Experiential Learning Programme are 1. Ornamental fish culture 2.Seed Production 3. Trade and export management 4. Aquaclinic 5. Post Harvest technology 6. Aqua farming.
A total of 12 credits are allotted for Experiential Learning Programme and the evaluation of the same will be conducted by the Committee appointed by the Dean of the respective college.

c) **Project work:** Studentwillselectrelevant or interested area of specialization such as Fish pathology, Fish diagnosis, Fish pharmacology, Fish Toxicology, Fish nutrition, Fish immunology, Fish genetics and breeding, Ornamental fish production, Genomics in Aquaculture, Fish stock assessment, Aquatic pollution, Fish value addition, Fish in nutrition, Fish processing waste management, Quality control and quality assurance, Fish products and by-products etc.. He/she will prepare a research project plan and it will be presented in-front of committee appointed by the Dean of the respective college. Also, for each student, one advisor will be provided, who will guide the student in completion of proposed research plan. A total of 2 credits are allotted for project work and 1 credit for (completed project work presentation) seminar. The evaluation for the same will be conducted by the committee appointed by the Dean of the respective college.

Overall changes effected in the course curriculum and syllabus by the V Deans Committee recommendations

- New courses for 9 credit hrs on Pharmacology, Chemotherapy, Toxicology and Immunology have been added to address health of both fish and the consumer. Also a new course on Aquatic mammals, reptiles and amphibians included.
- A new Department on Aquatic Animal Health Management created in view of its importance in the rapidly growing aquaculture industry. Furthermore, Department of Fishery Engineering has been carved out of Dept. of Post Harvest Technology.
- Student Ready Programme has been strengthened with 40 credit hrs without diluting curriculum of theory courses. The programme has RAWE 8 credits hrs, Inplant training 10 credit hrs, Experiential learning 17 credit hrs and other Skill development, Educational Tour and Seminar- total 8 credit hrs.
- Only two compulsory non-credit courses with one class per week on 1) swimming 2) physical Education, First aid and Yoga are included.
- Course syllabus was reviewed for including latest content and avoiding repetition.

Department wise distribution of syllabus

DEPARTMENT OF AQUACULTURE

AQC 111 Principles of Aquaculture 2 (1+1)

Theory

Basics of aquaculture, definition and scope. History of aquaculture: Present global and national scenario. Aquaculture vs Agriculture. -**1hr.** Systems of aquaculture - pond culture, pen culture, cage culture, running water culture and zero water exchange system-**2hrs.**Extensive, semi-intensive, intensive and super intensive aquaculture in different types of water bodies viz., freshwater, brackish water inland saline and marine water-**2hrs.** Principles of organic aquaculture- **1hr.** Pre-stocking and post stocking pond management- **2hrs.** Carrying capacity of pond, factors influencing carrying capacity-**2hrs.** Criteria for selection of candidate species for aquaculture-**1hr.** Major candidate species for aquaculture: freshwater, brackish-water and marine- **3hrs.** Monoculture, polyculture and integrated culture systems-**1hr.** Water and soil quality in relation to fish production. Physical, chemical and biological factors affecting productivity of ponds-**3hrs.**

Practicals:

Aquaculture production statistics- world and India. Aquaculture resources of world and India. Components of Aquaculture farms. Estimation of carrying capacity. Practices on pre-stocking and post stocking management. Growth studies in aquaculture system. Study on waste accumulation in aquaculture system (NH_3, Organic matter, CO_2). Analysis of manure.

Suggested Readings:

1. Bardach JE. 1997. *Sustainable Aquaculture*. John Willey & Sons.
2. FAO 2001. *Planning and Management for Sustainable Coastal Aquaculture Development*. FAO
3. Boyd, C. E. and Tucker, C. S. 1992. Water Quality and Pond Soil Analyses for Aquaculture, Alabama Agricultural Experimental Station, Auburn University.
4. Boyd CE. 1979. *Water Quality in Warm Water Fish Ponds*. Auburn University.
5. ICAR. 2006. *Handbook of Fisheries and Aquaculture*. ICAR
6. Jhingran VG. 1991. *Fish and Fisheries of India*. Hindustan Publ.
7. Landau M. 1992. *Introduction to Aquaculture*. John Wiley & Sons.
8. Pillay TVR & Kutty MN. 2005. *Aquaculture- Principles and Practices*. Blackwell Publications.
9. Thorpe JE, Gall GAE, Lannan JE & Nash CE. (Eds.). 1995. *Conservation of Fish and Shellfish Resources, Managing Diversity*.
10. CMFRI Bulletin. 1987. *National Seminar on Shellfish Resources and Farming*.
11. Rath RK. 2000. *Freshwater Aquaculture*. Scientific Publ.
12. Best Management Practices for Responsible Aquaculture Claude E. Boyd, Chhorn Lim, Julio Queiroz, Khalid Salie, Lorens de Wet & Aaron McNevin
13. FAO Fisheries Technical Paper 407. Integrated Agriculture.- Aquaculture, A Primer.
14. Yearbook of Fisheries and Aquaculture-2015.
15. The State of World Fisheries and Aquaculture 2016. FAO.

AQC 112 Fundamentals of Biochemistry 3 (2+1)

Theory

A brief introduction to developments in biochemistry and its transformation to molecular biology-**1 hr**. Cell structure, water and major molecules of life-**1 hr**. Carbohydrate chemistry: Structure, classification, functions (mono, di and polysaccharides) isomerism and mutarotation-**2 hrs**. Metabolism of carbohydrates: glycolysis, gluconeogenesis, glycogenolysis, glycogenesis, TCA cycle, central role of TCA cycle in metabolism- **6 hrs**. Protein chemistry: classifications and functions. Classification, structure, function and properties of amino acids-**2hrs.** Essential and non essential amino acids. Primary, secondary, tertiary and quaternary structure of proteins. Amphoteric property. Biuret reaction and xanthoproteic reaction. Digestion and absorption of proteins -**6 hrs**. Classification, structure, functions and properties of lipids. Essential fatty acids and phospholipids. Digestion and absorption of lipids. Lipid autooxidation. Significance of Omega-3 and Omega-6 fatty acids- **6 hrs**. Enzymes: nomenclature; classification; specificity; mechanism of enzyme action; kinetics and regulation of enzyme activity- **2 hrs**. Steroid and peptide hormones- chemistry and function -**3 hrs**. Structure and functions of fat and water soluble vitamins. Vitamins – classification- functions -**2 hrs**. Minerals – classification – functions-**1 hr**. Nucleic acids: Structure function and importance genetic code. Transcription and translation. Protein synthesis. Energy changes in chemical reactions, reversible and irreversible reactions in metabolism-**4 hrs**.

.

Practicals

Preparation of normal solution of acid and base, buffers and reagents. Qualitative determination of carbohydrates, proteins and lipids. Estimation of total nitrogen and crude protein of fish tissue. Estimation of carbohydrates in foods. Determination of specific gravity of oil. Extraction and estimation of total lipids in fish tissue. Determination of saponification value, iodine value and free fatty acid value.

Suggested Readings

1. Donald Voet, Judith G. Voet and Charlotte W. Pratt., Fundamentals of Biochemistry: Life at the Molecular Level , Published by John Wiley & Sons.
2. Albert L. Lehninger, David L. Nelson, Michael M. Cox, Lehninger Principles of Biochemistry, Pub. W.H. Freeman.
3. Conn EE & Stumpf PK 1976. Outlines of Biochemistry, Wiley Eastern.
4. Harper. REvirew of Biochemistry.
5. Leghinger AL, 1993. Principle sof Biochemistry. Northe Publishers, New York.
6. Sadasivam And Manickan, 1992. Bio Chemical Methods. Wilie Eastern Ltd.
7. White A, Handler P and Smith EL. 1983. Priniciples of Biochemistry. Mchrow Hill.

AQC 121 Fresh Water Aquaculture3 (2+1)

Theory

Major species cultured, production trends and prospect in different parts of the world**2 hr**. Freshwater aquaculture resources-ponds, tanks, lakes, reservoirs etc.- **2hrs**. Nursery, rearing and grow-out ponds preparation and management- **2hrs.** control of aquatic weeds and algal blooms, predatory and weed fishes-**2hr**s. Liming, fertilization/manuring, use of biofertilizers, supplementary feeding- **2 hrs**. Water quality management-**2 hrs**. Selection, transportation and acclimatization of seed-**1 hr**. Traits of important cultivable fish and shellfish and their culture methods-Indian major carps, exotic carps, air breathing fishes, cold water fishes, freshwater prawns, mussels- **5hrs**. Wintering ponds, quarantine ponds and isolation ponds-**1 hr**. Sewage-fed fish culture. Principles of organic cycling and detritus food chain-**3hrs**. Use of agro-industrial waste and biofertilizer in aquaculture-**2hrs**. Composite fish culture system of Indian and exotic carps-competition and compatibility **-2 hrs**. Exotic fish species introduced to India. Culture of other freshwater species-**2 hrs**. Medium and minor carps, catfish and murrels-**2 hrs**. Species of fish suitable for integrated aquaculture. Integration of aquaculture with agriculture/horticulture. Integration of aquaculture with livestock-**3 hrs**. Cultivation of aquatic macrophytes with aquaculture (makahana)-**2 hrs**. Paddy cum Fish/Shrimp Culture-**1 hr**.

Practicals

Preparation and management of nursery, rearing and grow-out ponds. Study on effect of liming, manuring and fertilization on hydrobiology of ponds and growth of fish and shellfishes. Collection, identification and control of aquatic weeds, insects, predatory fishes, weed fishes and eggs and larval forms of fishes. Algal blooms and their control. Estimation of plankton and benthic biomass. Study of contribution of natural and supplementary feed to growth. Workout of economics of different culture practices. Estimation of live stock requirement / Unit in integrated aquaculture Design of paddy plot for paddy-cum-fish culture. Design of Fish and Shrimp Culture, livestock shed on pond embankment, Economics of different integrated farming systems.

Suggested Readings

1. FAO. 2007. *Manual on Freshwater Prawn Farming*
2. FAO. 2007. *Manual for Operating a Small Scale Recirculation FreshwaterPrawn Hatchery*.
3. Adhikari S & Chatterjee DK. 2008. *Management of Tropical FreshwaterPonds*. Daya Publ.
4. Anon. 1987. *Better freshwater fish farming*. Further improvement. FAO Better Farming Series. F.A.O. UNIPUB. No pp. given. ISBN 92-5-102161-9
5. Bardach JE. 1997. *Sustainable Aquaculture*. John Willey & Sons.
6. FAO 2001. *Planning and Management for Sustainable Coastal Aquaculture Development*. FAO
7. Boyd, C. E. and Tucker, C. S. 1992. Water Quality and Pond Soil Analyses for Aquaculture, Alabama Agricultural Experimental Station, Auburn University.
8. Boyd CE. 1979. *Water Quality in Warm Water Fish Ponds*. Auburn University.
9. ICAR. 2006. *Handbook of Fisheries and Aquaculture*. ICAR

10. Jhingran VG. 1991. *Fish and Fisheries of India*. Hindustan Publ.
11. Landau M. 1992. *Introduction to Aquaculture*. John Wiley & Sons.
12. Pillay TVR & Kutty MN. 2005. *Aquaculture- Principles and Practices*. Blackwell Publications.
13. Thorpe JE, Gall GAE, Lannan JE & Nash CE. (Eds.). 1995. *Conservation of Fish and Shellfish Resources, Managing Diversity*.
14. CMFRI Bulletin. 1987. *National Seminar on Shellfish Resources and Farming*.
15. Rath RK. 2000. *Freshwater Aquaculture*. Scientific Publ.
16. Best Management Practices for Responsible Aquaculture Claude E. Boyd, Chhorn Lim, Julio Queiroz, Khalid Salie, Lorens de Wet & Aaron McNevin
17. FAO Fisheries Technical Paper 407. Integrated Agriculture.- Aquaculture, A Primer.
18. Yearbook of Fisheries and Aquaculture-2015.
19. The State of World Fisheries and Aquaculture 2016. FAO.

AQC 122 Fish Nutrition and Feed Technology 3 (2+1)

Theory

Fundamentals of fish nutrition and growth in fish-**2 hrs**. Principal nutrients and nutritional requirements of cultivable fish and shellfish-**3 hrs**. Nutritional energetics: definition and forms of energy partitioning-**3 hrs**. Methods of feed formulation and manufacturing-**4 hrs**. Forms of feeds: wet feeds, moist feeds, dry feeds, mashes, pelleted feeds, floating and sinking pellets. Feed additives: binders, antioxidants, enzymes, pigments, growth promoters, feed stimulants-**4 hrs**. Feed storage: use of preservatives and antioxidants-**3 hrs**. Feed evaluation: feed convertion ratio, feed efficiency ratio, protein efficiency ratio, net protein utilization and biological value **-4 hrs**. Feeding devices and methods-**3 hrs**. Non-conventional feed ingredients and antinutritional factors-**2 hrs**. Digestive enzymes, feed digestibility-**3 hrs**. Factors affecting digestibility -**2 hr**. Nutrional deficiency diseases-**3 hrs.**

Practicals

Proximate composition analysis of feed ingredients and feeds. Preparation of artificial feeds using locally available feed ingredients. Determination of sinking rate and stability of feeds. Effect of storage on feed quality.

Suggested Readings

1. D' Abramo LR, Conklin DE & Akiyama DM. 1977. *Crustacean Nutrition:Advances in Aquaculture*. Vol. VI. World Aquaculture Society,BatonRoughe.
2. Guillame J, Kaushik S, Bergot P &Metallier R. 2001. *Nutrition andFeeding of Fish and Crustaceans*. Springer Praxis Publ.
3. Halver J & Hardy RW. 2002. *Fish Nutrition*. Academic Press.
4. Halver JE &Tiews KT. 1979. *Finfish Nutrition and Fish feed Technology*.Vols. I, II Heenemann, Berlin.
5. Hepher B. 1988. Nutrition of Pond fishes. Cambridge University. Academic Press.
6. Jain KK and Srivastava PP 2003. Fish and Prawn Feed Technology. CIFE 127 p.
7. De Silva SS & Anderson TA. 1995. *Fish Nutrition in Aquaculture*.Chapman & Hall Aquaculture Series.
8. Lovell RT. 1998. *Nutrition and Feeding of Fishes*. Chapman & Hall.

9. New MB. 1987. *Feed and Feeding of Fish and Shrimp. A Manual on thePreparation and Preservation of Compound Feeds for Shrimp andFish in Aquaculture*. FAO – ADCP/REP/87/26.

AQC 123 Aquaculture in Reservoir 2 (1+0)

Theory

Definition of reservoirs in India; nature and extent of reservoirs-**1 hr**. topography and species diversity-**1 hr**. importance of morpho-edaphic index in reservoir productivity and classification-**1 hr**; factors influencing fish production-**1 hr**. trophic phases in reservoir-**1 hr**. pre-impoundment and post-impoundment stages and their significance in establishment of reservoirs fisheries- **1 hr**. Salient features of reservoir limnology and their significance to fisheries development; management of small, medium and large reservoirs; present status and future prospects in reservoirs fish production **- 2 hrs.**

Fisheries of some important reservoirs; recent advances in reservoirs fisheries management; conservation measures in reservoir fisheries. Fish stocking in Reservoirs-**2 hrs.** Role of cage and pen culture in enhancement of fish production from reservoirs; history of cage culture, advantages of cage culture; selection of suitable site of cage culture; cage materials, designs, shape, size and fabrication; cage frames and supporting system. Integration of cage culture with other farming systems-**2 hrs.** History of pen culture, pen materials, fabrication; breeding of fish in pen; rearing of spawn in pen; grow-out from pens. Suitable species for culture in cages and pens; constraints in cage and pen culture; economics of cage and pen culture **-3 hrs**.

Preparation of charts on the present situation of reservoirs fisheries productivity; detailed case studies of selected reservoirs on the changing trends in capture fisheries profile; drawing inferences from the analysis of data; suggestions for the sustainable development of reservoirs fisheries. Case studies on cage and pen culture; field visit to cage and pen culture site to acquaint with construction details and operation **- 3hrs.**

Suggested Readings

1. De Silva SS. (Ed.). 2001. *Reservoir and Culture Based Fisheries: Biology and Management*. ACAIR Proceedings.
2. Boyd CE. 1979. *Water Quality in Warm Water Fish Ponds*. Auburn University.
3. ICAR. 2006. *Handbook of Fisheries and Aquaculture*. ICAR
4. Jhingran VG. 1991. *Fish and Fisheries of India*. Hindustan Publications.

AQC 211 Fish Food Organisms 2 (1+1)

Theory

Candidate species of phytoplankton and zoo-plankton as live food organisms of freshwater and marine species-**3 hrs**. Tropic potentials - proximate composition of live feed-**3 hrs**. Biology, culture requirements and methodology of important live food organisms **-4 hrs**. Green algae, blue-green algae, spirulina, diatoms, infusoria, rotifers, cladocerons, tubifex, brine shrimp, chironomids- **6 hrs.**. Culture of earthworms, bait fish and forage fish-**2 hrs.**

Practicals

Methods of collection and identification of different live food organisms. Laboratory scale culture of selected live food organisms (green algae, spirulina, chetoceros, rotifer, Moina, copepod). Evaluation of live food organisms. Decapsulation and hatching method of brine shrimp cyst.

Suggested Readings

1. MPEDA. 1993. *Handbook on Aqua Farming - Live Feed. Micro Algal Culture.* MPEDA Publication.
2. Sorgeloos P & Pandian KS. 1984. *Culture of Live Food Organisms withSpecial Reference to Artemia Culture*. CMFRI Spl. Publ. No. 15.
3. Charles and Masters, 1975. Encyclopedia of live foods. TFH Publicastions Inc. Ltd.
4. Sasi Nayar, Shripad Hegde, Srinivas Rao and Sudha P. 1998. Live Organisms as feed in Aquaculture. INFOSFISH.
5. Soregloos P and Lavens P 1996. Manual on the production of and use of live feed for Aquaculture. FAO. Technical Paper 367.
6. Venkataraman G.S. 1969. The Cultivation of Algae. ICAR Publication.

AQC 212 Introduction to Biotechnology & Bioinformatics 2 (1+1)

Theory

Biotechnology**:** Introduction to Biotechnology –scope and importance in fisheries/aquaculture **-1hr**; Structural organization of prokaryotic and eukaryotic cell. Nucleic acids -structure, function and types-**1 hr**, Concepts of gene and genetic code, transcription and translation- **2hrs.** mutations and their implications-**1 hr**. Post transcriptional modification and RNA processing -**1 hr**. Gene regulation and expression in prokaryotes and eukaryotes-**1 hr**. DNA sequencing, Operons-**1hr.** Genetic engineering- Restriction enzymes; Gene isolation; Cloning vectors; Probes-**2 hrs**.Recombinant DNA technology – vaccines. Transgenic fish and Gene transfer technology -**2 hrs**. Animal Cell Culture, Hybridoma technology. Molecular and immunological techniques – PCR; immunoblotting; ELISA; Principle of hybridization; Northern blotting; Western blotting; Southern blotting; DNA fingerprinting; Restriction fragment length polymorphism., Biosensors. Concept of bioremediation of water, bioprocess engineering and bioprospecting -**4 hrs**.

Bioinformatics**:** Introduction to Bioinformatics; Biological Databases and tools : Introduction; Types of biological databases; Primary and secondary databases; PDB, NCBI, formats and contents; Sequence retrieval, manipulation; Primer design; Restriction mapping; ORF finding; EMBOSS, Molecular visualization Sequence analysis-**2 hrs**.

Practicals

Study of structure of prokaryot and Eukaoryt Cells. Study on Model of protein Synthesis, Study of models rDNA Technology, Cell Culture, Isolation of Nucleic Acids, Restriction enzymes, Gel Electrophorus, ELISA, DNA sequence analysis and comparison.

Suggested Readings

1. Molecular Biotechnology: Principle and application of Recombinant DNA Technology by Bernard R Glick, Jack J Pasternack and Cheryl L Pattan. ASM Press 4th Edition.

2. Biotechnology by U.Satyanarayana. Books and allied (p) Ltd. India
3. Genomes 3 by T.A. Brown. Garland Science
4. Introduction to bioinformatics. 3rd edition by Arthur M Lesk. Oxford publishers
5. Essential Bioinformatics. By Jin Xiong. Cambridge University Press

AQC 221 Coastal Aquaculture and Mariculture 3 (2+1)

Theory

An overview of sea farming and shore-based aquaculture in different parts of the world **-2 hrs**. Resources for shore-based aquaculture and sea farming in India-**1hr**. Traits of important cultivable fish and shellfish (seabass, mullet, milkfish, grouper, cobia, snappers, ayu, pearlspot, tiger shrimp, white shrimp, mud crab, mussel, clam, oysters (edible and pearl oyster), lobster, seaweeds -**8 hrs**. Seed resources-**2 hrs**. Shore based aquaculture system: traditional (pokkali, bheries, gazanis, khazans), semi- intensive, intensive aquaculture practice of commercially important species of fish and shellfish-**6 hrs**. Methods of Shellfish Culture rafts, racks, cages, poles and ropes -**5 hrs**. Water and soil quality management-**4 hrs**. Estimation of growth, survival and pond productivity-**2 hrs**. Seaweed culture-**2 hrs**, Pearl culture-**2 hrs**. Sea ranching-**2 hrs**.

.

Practicals

Identification of important cultivable species. Collection and identification of commercially important seed of fish and shellfishes. Types of fertilizers - Pond preparation. Seed selection, quality and acclimatization. Water quality parameters. Estimation of seed survival. Pond biomass estimation. Material, apparatus and machinery for shore-based aquaculture and sea farming. Estimation of feed intake. Growth and health monitoring. Fouling organisms in cages and pens.

Suggested Readings

1. Mcvey JP. 1983. *Handbook of Mariculture*. CRC Press.
2. FAO 2001. *Planning and Management for Sustainable CoastalAquaculture Development*. FAO
3. James PM. 1983. *Handbook of Mariculture*. Vol. I. *CrustaceanAquaculture*. CRC Press.
4. Bardach JE. 1997. *Sustainable Aquaculture*. John Willey & Sons.
5. FAO 2001. *Planning and Management for Sustainable Coastal Aquaculture Development*. FAO
6. Boyd, C. E. and Tucker, C. S. 1992. Water Quality and Pond Soil Analyses for Aquaculture, Alabama Agricultural Experimental Station, Auburn University.
7. Boyd CE. 1979. *Water Quality in Warm Water Fish Ponds*. Auburn University.
8. ICAR. 2006. *Handbook of Fisheries and Aquaculture*. ICAR
9. Jhingran VG. 1991. *Fish and Fisheries of India*. Hindustan Publ.
10. Landau M. 1992. *Introduction to Aquaculture*. John Wiley & Sons.
11. Pillay TVR & Kutty MN. 2005. *Aquaculture- Principles and Practices*. Blackwell Publications.
12. Thorpe JE, Gall GAE, Lannan JE & Nash CE. (Eds.). 1995. *Conservation of Fish and Shellfish Resources, Managing Diversity*.
13. CMFRI Bulletin. 1987. *National Seminar on Shellfish Resources and Farming*.
14. Best Management Practices for Responsible Aquaculture Claude E. Boyd, Chhorn Lim, Julio Queiroz, Khalid Salie, Lorens de Wet & Aaron McNevin

15. FAO Fisheries Technical Paper 407. Integrated Agriculture.- Aquaculture, A Primer.
16. Yearbook of Fisheries and Aquaculture-2015.
17. The State of World Fisheries and Aquaculture 2016. FAO.

AQC 311 Finfish Hatchery Management 3 (2+1)

Theory

Freshwater and marine fish seed resources-**2 hrs**. Natural breeding of finfishes-**2 hrs**. Selection of riverine spawn collection sites, gears used and methods of collection**2 hrs**. Spawn quality and quantity indices-**1 hr**. Advantages and disadvantages of riverine seed collection-**1 hr**. Sexual maturity and breeding season of various cultivable species-**2 hrs**. Development of gametes in male and female-**2 hrs**. Fish egg and embryonic development-**2 hrs**. Methods of breeding; bundh breeding - wet and dry bundhs, collection and hatching of eggs, factors involved in bundh breeding, advantages and disadvantages of bundh breeding-**4 hrs**. Induced breeding of warmwater finfishes, environmental factors affecting spawning, sympathetic breeding. Hypophysation of fishes. Fish pituitary gland – its structure, collection, preservation and preparation of extract for injection, dosages and methods of injection. Brood-stock management and transportation of brood fish-**4 hrs**. Synthetic hormones used for induced breeding of carps-**1 hr**. Different types of fish hatcheries-traditional, Chinese, glass jar and modern controlled hatcheries-**4 hrs**. Causes of mortalities of eggs and spawn and remedies-**1 hr**. Spawn rearing techniques **-1hr**. Use of anesthetics in fish breeding and transport-**1hr**. Breeding techniques for Indian major carps, exotic carps, mahaseers, trouts, tilapias, catfishes, grey-mullets, milk fish, pearl spot, sea bass, sea hourse, groupers, pacu, cobia, pompanos and indigenous fishes, etc.- **5 hrs.** Off-season andmultiple breeding of carps-**1 hr**.

Practicals

Study of maturity stages in fishes. Collection and preservation of fish pituitary gland, preparation of PG extract, Hypophysation. Calculation of fecundity. Brood-stock maintenance and selection of breeders for injection. Histological studies of ovary and testes. Different fish hatchery systems, study of fish eggs and embryonic developmental stages. Identification of eggs, spawn, fry and fingerlings of different species. Preparation and management of fish nursery. Fish seed and brood-stock transportation, use of anesthetics, disinfectants and antibiotics in fish breeding. Water quality monitoring in fish hatcheries and nurseries. Breeding and larval rearing of common finfishes.

Suggested Readings

1. Jhingran VG &Pullin RSV. 1985. *Hatchery Manual for the Common,Chinese and Indian Major Carps*. ICLARM, Philippines. Chondar S L 1988. Hypophysation of Indian Major Carps. Satish Book Enterprises. 146 p.
2. Harvey B.J. and Haar WS. 1985. The theory and practices of induced breeding in fish. IDRC Publication. 49p.
3. ICAR, New Delhi. A Hand Book of Fisheries and Aquaculture.
4. Jhingran VG and Sehgal KL, Cold Water Fishers of India. Inland Fisheries Society of India. 239 p.
5. Jhingran VG 1991. Fish and Fisheries of India. Hindustan Publishing House.

6. Pillay TVR and M N Kutty. Aquacukture: Principle and Practices. Black Well.

AQC 312 Shellfish Hatchery Management 3 (2+1)

Theory

Natural seed resources, site selection and collection methods -**3 hrs**. Life cycle of important shellfish (*Penaeus monodon*, *P. indicus*, *Macrobrachiumrosenbergii*, *P. Vannamei*, *Scylla serrata*, lobster, edible, oyster, pearl oyster, fresh water mussel, holothurians, horse-shoe carb, Sepia, Loligo, cray fish etc.) -**4 hrs**. Sexual maturity and breeding seasons of different species. Maturation stages of *Macrobrachium rosenbergii* and *Penaeus monodon*. and *P. Vannamei* -**3 hrs**. Induced maturation in *Penaeus monodon* and *P. Vannamei P. Indicus* by eye stalk ablation **3 hrs.** Reproductive physiology- **2 hrs.** Reproductive harmones in crustaceans -**2 hrs**. Brood stock management of *Penaeus monodon* and *Macrobrachiumrosenbergii*. -**3 hrs.** Breeding and hatchery management of *Penaeus monodon* and *Macrobrachiumrosenbergii*.- **3 hrs.** Breeding and hatchery management of crabs, lobster, mussel, edible and pearl oyster-**6 hrs.** Food and feeding of larval stages of important shellfishes -**4 hrs.**. Health management in hatcheries- **3 hrs.**

Practicals

Identification of brood stock and maturity stages of important crustaceans and mollusks. Observations on gonadal maturation of *Penaeus monodon* and *Macrobrachium rosenbergii*. Breeding and larval rearing of *Macrobrachium rosenbergii* and *Penaeus monodon* P. Vannamei. Identification of larval stages of important crustaceans and mollusks. Demonstration of eyestalk ablation in *Penaeus monodon*. Collection, packing and transportation of shrimp/prawn seed and brood stock. Practice in the operation of shrimp and prawn hatcheries. Water treatment and management in shrimp and prawn hatcheries. Different chemicals and drugs used in shrimp/prawn hatchery.

Suggested Readings:

1. Gary A. Wedemeyer, Fish Hatchery Management.New and Valenti 2000. Freshwater Prawn Culture. Black Well.Mcvey JP. 1983. *Handbook of Mariculture*. CRC Press.
2. FAO 2001. Planning and Management for Sustainable CoastalAquaculture Development. FAO.
3. James PM. 1983. *Handbook of Mariculture*. Vol. I. *Crustacean Aquaculture*. CRC Press.
4. Bardach JE. 1997. *Sustainable Aquaculture*. John Willey & Sons.
5. FAO 2001. *Planning and Management for Sustainable Coastal Aquaculture Development*. FAO
6. Boyd, C. E. and Tucker, C. S. 1992. Water Quality and Pond Soil Analyses for Aquaculture, Alabama Agricultural Experimental Station, Auburn University.
7. Boyd CE. 1979. *Water Quality in Warm Water Fish Ponds*. Auburn University.
8. ICAR. 2006. *Handbook of Fisheries and Aquaculture*. ICAR
9. Jhingran VG. 1991. *Fish and Fisheries of India*. Hindustan Publ.
10. Landau M. 1992. *Introduction to Aquaculture*. John Wiley & Sons.
11. Pillay TVR & Kutty MN. 2005. *Aquaculture- Principles and Practices*. Blackwell Publications.
12. Thorpe JE, Gall GAE, Lannan JE & Nash CE. (Eds.). 1995. *Conservation of Fish and Shellfish Resources, Managing Diversity*.
13. CMFRI Bulletin. 1987. *National Seminar on Shellfish Resources and Farming*.

14. Best Management Practices for Responsible Aquaculture Claude E. Boyd, Chhorn Lim, Julio Queiroz, Khalid Salie, Lorens de Wet & Aaron McNevin

AQC 321 Ornamental Fish Production and Management 2 (1+1)

Theory

History of ornamental fish keeping-**1hr**. Classification of ornamental fishes distribution of ornamental fishes- **1hr.** Endemic, exotic and indigenous fishes- **1hr.** Principles of a balanced aquarium-**1hr**. Fabrication, setting up and maintenance of freshwater and marine aquarium**1 hr**. Water quality management **-1hr**. Aquarium accessories and decorative- **1hr**. Aquarium fish feeds. Dry, wet and live feeds-**1hr**. Broodstock management. Breeding and rearing of ornamental fishes -**1 hr**. Water filtration system-biological, mechanical and chemical- **1hr**. Types of filters**.** Lighting and aeration-**1hr**. Application of genetics and biotechnology for producing quality strains-**1hr**.. Trade regulations and wild life act in relation to ornamental fishes-**1hr**. Design and production plan for backyard fish hatchery. Best management Practices for ornamental fish farms. Biosecure ornamental fish production and quarantine procedure-**2hr.** Common fish diseases and their control. Harvesting, sorting, conditioning, packing, transport and quarantine procedures. Aquarium plants and their propagation methods **-1 hr**. World trade in ornamental fishes. Export potential of Indian fishes. Ornamental fish certification and export procedure. trade regulation and wildlife act in relation to ornamental fishes-**2 hrs.**

Practicals

Identification of common ornamental fishes and plants. Fabrication of all-glass aquarium. Setting up and maintenance of Aquarium accessories and equipment. Conditioning and packing of ornamental fishes. Preparation of feed. Setting up of breeding tank for live bearers, barbs, goldfish, tetras, chiclids, gouramis, fighters and catfishes. Identification of ornamental fish diseases and prophylactic measures.

Suggested Readings

1. Axelrod, H.R., G.S. Axelrod, W.E. Burgess, B.M. Scott, N. Pronek, and J.G. Walls. 2004. *Atlas of Freshwater Aquarium Fishes.* Neptune City, NJ: T.F.H. Publications, Inc.
2. Cato, J.C. and C.L. Brown. 2003. *Marine Ornamental Species: Collection, Culture, and Conservation*. Ames, IA: Iowa State Press.
3. Chapman, F.A. 2000. Ornamental fish culture, freshwater. In: R.R. Stickney (ed), *Encyclopedia of Aquaculture*, pp. 602-610. New York, NY: John Wiley & Sons, Inc.
4. Gratzek, J.B. 1994. *Aquariology: The Science of Fish Health Management*. Morris Plains, NJ: Tetra Press.
5. Kasselmann, C. 2002. *Aquarium Plants*. Malabar, FL: Krieger Publishing Company.

AQC 322 Genetics and Breeding 2 (1+1)

Theory

Principles of genetics and breeding **-1 hr**. Gene and chromosome as basis of inheritance- **1 hr**.Mendel's law of inheritance – complete and incomplete dominance, monohybrid and dihybrid ratios- **2 hrs**. Gene interactions – dominant and recessive epistasis. Pleiotropism. Lethal genes.

Mutation -**1 hr**. Sex - linked genes, sex influenced and sex limited traits. Linkage and crossing over. Introduction to population genetics. Hardy- Weinberg law and its significance. Chromosomal structure and aberrations- **3 hrs**. Chromosome manipulation techniques- androgenesis, gynogenesis and polyploidy and identification of ploidy- **2 hrs**. Sex determination. Cross breeding (hybridization) – types of cross breeding, heterosis and design of cross breeding programmes, hybridization in different fishes. Quantitative genetics – quantitative traits, polygenic traits, heritability- **3 hrs**.

History and present status of selective breeding programs in aquaculture- **1 hr**. Selection methods and mating designs. Design for selective breeding. Inbreeding and its consequences- **2hrs.** Domestication methods. Seed certification and quarantine procedures. Cryopreservation of gametes -**2 hrs**.

Practicals

Problems on Mendelian inheritance (qualitative genetics) - monohybrid and dihybrid ratios and epistasis. Problems on quantitative traits, response to selection and heritability. Estimation of rate of inbreeding and heterosis. Mitotic and meiotic chromosome preparation. Demonstration of protocol of androgenesis, gynogenesis and polyploidy. Problems on gene and genotypic frequency. Gamete cryopreservation protocols and quality evaluation of fish milt.

Suggested Readings

1. Purdom CE. 1993. *Genetics and Fish Breeding*. Chapman & Hall.
2. Carvalho GR & Pitcher TJ. (Eds.). 1995. *Molecular Genetics in Fisheries*.Chapman & Hall.
3. Falconer DS & Mackay. 1996. *Introduction to Quantitative Genetics*. 4thEd. Longman.
4. Nair PR. 2008. *Biotechnology and Genetics in Fisheries and Aquaculture*. Dominant
5. PPadhi BK & Mandal RK. 2000. *Applied Fish Genetics*. Fishing Chimes.
6. Pandian TJ, Strüssmann CA & Marian MP. 2005. *Fish Genetics andAquaculture Biotechnology*. Science Publ.
7. Thomas PC, Rath SC &Mohapatra KD. 2003.*Breeding and SeedProduction of Finfish and Shellfish*. Daya Publ.
8. Reddy PVGK, Ayyappan S, Thampy DM & Krishna G. 2005. *Text book of Fish Genetics and Biotechnology*. ICAR.
9. Ryman N & Utter F. (Eds.). 1988. *Population Genetics and Fishery Management*. Washington Sea Grant Programmes, USA.
10. Tave D. 1996. Genetics for Fish Hatchery Managers. 2nd Ed. AVI Publ.

DEPARTMENT OF FISHERIES RESOURCE MANAGEMENT

FRM 111 Taxonomy of Finfish 3 (1+2)

Theory

Principles of taxonomy and Nomenclature, types, ICZN -**1hr**. Classification and interrelationships -**1 hr**. Criteria for generic and specific identification- **1hr**. Morphological, morphometric and meristic characteristics of taxonomic significance -**1 hr**. Major taxa of inland and marine fishes up to family level. Commercially important freshwater and marine fishes of India and their morphological characteristics- **2 hrs**. Elasmobranch families: Heterodontidae, Hemiscylliidae, Rhincodontidae, Pseudocarchariidae, Alopiidae, Lamnidae, Carcharhinidae, Sphyrnidae, Squalidae, Torpedinidae, Narcinidae, Rajidae, Rhinobatidae, Rhynchobatidae, Pristidae, Dasyatidae, Mylobatidae- **3 hrs.** Teleost families: Elopidae, Megalopidae, Muraeinidae, Congridae, Anguillidae, Osteoglossidae, Notopteridae, Engraulidae, Clupeidae, Chirocentridae, Chanidae, Cyprinidae, Balitoridae, Cobitidae, Nemacheilidae, Botiidae, Siluridae, Pangasiidae, Ailiidae, Bagridae, Clariidae, Horabagridae, Plotosidae, Ritidae, Sisoridae, Erethistidae, Amblycipitidae, Schilbeidae, Heteropneustidae, Ariidae, Salmonidae, Holocentridae, Apogonidae, Gobiidae, Ambassidae, Pomcentridae, Mugilidae, Cichlidae, Exocoetidae, Hemiramphidae, Belonidae, Aplocheilidae, Mastacembelidae, Rachycentridae, Carangidae, Sphyraenidae, Xiphiidae, Istiophoridae, Anabantidae, Osphronemidae, Channidae, Nandidae, Badidae, Pristolepedidae, Psettodidae, Centropomidae, Latidae, Gerreidae, Mullidae, Chaetodontidae, Pomacanthidae, Lutjanidae, Siganidae, Nemipteridae, Sparidae, Lethrinidae, Tetraodontidae, Trichiuridae, Scombridae, Stromateidae- **6 hrs.** Introduction to modern taxonomic tools: molecular taxonomy and systematics, DNA Barcoding, Phylogenetics and Integrative Taxonomy - **3 hrs**.

Practicals

Collection and identification of commercially important inland and marine fishes. Study of their external morphology and diagnostic features. Modern taxonomic tools - Protein analysis and electrophoretic studies; Karyotaxonomy - chromosome preparation and identification. DNA barcoding, DNA polymorphism; Visit to fish landing centres to study commercially important fishes and catch composition.

Suggested Readings

Day, F. 1875 – 78 The fishes of India, being a natural history of the fishes known to inhabit the seas and freshwaters of India, Burma and Ceylon, Quaritch, London XX+778 pp. , 198 pls.

Ebert DA, Fowler SL, & Compagno LJV (2013) *Sharks of the World: a fully illustrated guide*. Wild Nature Press, 528p

Eschmayer W. (Ed) 1998. *The Catalog of Fishes*. San Francisco: California Academy of Sciences.

Jayaram KC (2010) *Freshwater fishes of the Indian region*. 2nd Edition. Narendra Publishing House 616p.

Fischer, W. and G. Bianchi (Eds.) 1984. FAO species identification sheets for fishery purposes. Western Indian Ocean (Fishing Area 51). Prepared and printed with the support of the Danish International Development Agency (DANIDA). Rome, Food and Agricultural Organization of the United Nations, Vols. 1-6:pag.var.

Nelson, J.S., 1976. Fishes of the world. A Wiley - Inter science publication. John Wiley & Sons (N.Y) pp. ix + 1- 416.

FRM 112 Anatomy and Biology of Finfish 3 (2+1)

Theory

Study of external and internal anatomy of important groups of finfish. Body form and locomotion, types of swimming, types of muscles- **2 hrs.** Study of oral region and associated structures (teeth, gill rakers, buccopharynx)-**2 hrs.** Digestive system and associated digestive glands. Anatomy of alimentary canal, Food and feeding habits of commercially important fishes.- classification of feeding types-predators, grazers, filter feeders, bottom feeders and parasites. Feeding indices- Qualitative and quantitative methods of analysis of gut contents- **4 hrs.** Circulatory system- structure and function of heart, constituents of blood-**2 hrs.** Respiratory system- anatomy of gills, mechanism of ventilation, accessory respiratory organs-**3 hrs.**

Nervous system- Brain and Sensory organs- eye, membraneous labyrinth, mechano receptor, thermo receptor, chemoreceptor and electro receptor organs in fish. Role of Weberian ossicles- **3 hrs.** Excretory system- Types and structure of kidney in fishes- **2 hrs.** Endocrine system- Major endocrine glands-structure and functions - **2 hrs.** Skeletal systems- osteology. Axial skeleton and appendicular skeleton - **2 hrs.** Reproductive biology – Anatomy of gonads, ovary, testis, ovotestis Hermaphroditism, gonochorism and gynogenesis. Reproductive adaptations-anatomical, energetic, behavioral and developmental. Maturity stages, gonado-somatic index, ponderal index, fecundity, sex ratio and spawning. Methods used in the study of maturation and spawning in fishes-size at first maturity, spawning season, spawning frequency and fecundity - **6 hrs.**

Eggs and larval stages and developmental biology. General features of early development in fishes, fertilization, cleavage, blastulation, gastrulation and organogenesis. Free embryo, larval metamorphosis, degree days concept and critical period concept, viviaprity in fishes and elasmobranchs-**4 hrs.**

Age and growth determination by direct and indirect methods. –layered data on hard parts, Peterson's method, Tagging and marking. Length weight relationships and condition factor, growth pattern-isometric and allometric. Methods of study of growth Petersen's method and back calculation of fish length from scale studies-**3 hrs.** Fish migration - type and significance. Feeding and reproductive migration-**2 hrs.**

Practicals

Study of internal organs – digestive, respiratory, circulatory, urino-genital system, nervous, skeletal systems and endocrine system. Study of food and feeding habits. Analysis of gut contents. Estimation of age and growth by direct and indirect methods. Classification of maturity stages. Estimation of fecundity. Study of developmental stages. Tagging and marking.

Suggested Readings

Agarwal, S.C., 2006. History of Indian fishery, Daya Publishing House, Delhi. 181 pp.
Bal, D.V. and K.V. Rao, 1990. Marine fisheries of India. Tate McGraw-Hill Publishing Company Limited, New Delhi. First revised edition. 472 pp.
Jordon, E.L. and P.S. Verma, 2008 . Chordate zoology, S. Chand and Company Ltd. pp. 1092
Khanna, S.S., 1993. An introduction to fishes, Central Book Depot, Allahabad, 530 pp.
Lagler, K.F., J.E. Bardach, R.R. Miller and D.R. May Passino, 1977. Ichthyology, (2nd Ed.), John Wiley and Sons, New York, 506 pp.
Moyle, P.B. and J.J. Cech, 1996. Fishes, an introduction to ichthyology. (3rd Ed.). Prentice Hall, Upper Saddle River, New Jersey, 590 pp.
Norman, J.R., 1975. A history of fishes, Ernest Benn Ltd., London, 467 pp.
Yadav, B.N., 2002. Fish and fisheries (2nd Ed.), Daya Publishing House, Delhi, 366 pp.

FRM 121 Taxonomy of Shellfish 2 (1+1)

Theory

Study of external morphology of crustacea (shrimp, crab and lobster) **-1 hr.** meristic characteristics of crustacean (shrimp, crab and lobster) **-1 hr.** Classification of crustacean up to the level of species with examples of commercially important species **-5 hrs**. *Acetes indicus, Penaeus monodon, Penaeus indicus, Penaeus merguiensis, Penaeus vannamei, Metapenaeus dobsoni, Metapenaeus affinis, Metapenaeus monoceros, Macrobrachium rosenbergii, Macrobrachium idella, Macrobrachium malcolmsonii, Parapenaeopsis stylifera, Scylla serrata, Scylla olivacea, Portunus pelagicus, Portunus sanguinolentus, Charybidis feriatus, Heterocarpus woodmasoni, Puerulus sewelli, Panulirus homarus, Panulirus ornatus, Panulirus polyphagus*- **3 hrs.** Study of external morphology of mollusca (Oyster, mussel, clam, squid, cuttlefish, octopus) **-1 hr.** meristic characteristics of mollusca (Oyster, mussel, clam, squid, cuttlefish, octopus)**-1 hr.** Classification of mollusca up to the level of species with examples of commercially important species- **4 hrs**. *Crassostrea madrasensis, Perna viridis, Perna perna, Villorita cyprinoides, Paphia malabarica, Anadora granosa, Tridacna maxima, Pinctada fucata, Pinctada margaritifera, Sepia pharaonis, Loligo duvaucelli, Cistopus indicus, Octopus vulgaris*- **2 hrs.**

Practicals

Study of external morphology. Collection, preservation and identification of commercially important prawns, shrimps, crabs, lobsters, bivalves, gastropods, cephalopods from natural habitats. Field visits for collection and study of commercially important shellfishes.

Suggested Readings

Burukovski, R.N. 1982. Key to Shrimps and Lobsters. Oxonian Press Fyi. Ltd..

Carpenter KE & VH Niem (1998) *FAO Species identification guide for fishery purposes. The living marine resources of the Western Central Pacific*. Vol 1. Seaweeds, corals, bivalves and gastropods. FAO, Rome.

Edward Griffith and Edward Pidgeon (Ed. Baron Cuvier), 1998. Handbook of Mollusca and Radiata. Biotech Books, Delhi.

Hoithuis, L.B. 1991. FAQ species catalogue. Marine lobsters of the world. An annoted and illustrated catalogue of species of interest to fisheries known to date. FAO Fisheries Synopsis. FAO. Rome, Vol. 13.

Jayachandran, K.V. and J. Raasekharan Nair 2003. Taxonomy and Biodiversity of Fishes and Crustaceans, ICAR sponsored short course manual. College of Fisheries, Kerala Agricultural University, Cochin.

Jerab P & Roper CFE (Eds) (2005) *Cephalopods of the world: an annotated and illustrated catalogue of cephalopod species known to date*. FAO Species Catalogue for fishery purposes. No 4(1). 262p

Silas, E.G. 1985. Cephalopod Bionomics, Fisheries and Resources of the Exclusive Economic Zone of India. CM FRI Bulletin 37. Central Marine Fisheries Research Institute, Cochin.

FRM 122 Anatomy and Biology of Shellfish 2 (1+1)

Theory

Study of external and internal organization of commercially important crustaceansand molluscs.Digestive, respiratory, circulatory, nervous and reproductive systems of crustaceans **4 hrs**. Food and feeding habits - **2 hrs**. growth, moulting- **1 hr**, Reproductive biology, larval stages- **2 hrs**. Age and growth determination by direct and indirect methods- **1 hr**. Digestive, respiratory, circulatory, nervous and reproductive systems of mollusks **-3 hrs**.Food and feeding habits - **1 hrs**. Reproductive biology, larval stages - **2 hrs**. length – weight relationship, age and growth determination by direct and indirect methods **-2 hrs.**

Practicals

Study of Internal Organs commercially important crustaceans and mollusks. Study of Digestive, respiratory, circulatory, nervous and reproductive systems. Study of food and feeding habits - analysis of gut contents, age and growth, length - weight relationship and condition. Reproductive biology: maturity stages, spawning periodicity, fecundity and larval stages.

Suggested Readings

Adiyodi KG & Adiyodi RG. 2000. *Reproductive Biology of Invertebrates*: Vol. X. Part B. *Progress in Developmental Endocrinology*. John Wiley & Sons.

Barrington EJW. 1981. *Invertebrate Structure and Function*. 2nd Ed. The English Language Book Society & Nelson.

Khan SA, Raffi SM & Lyla PS. 2003. *Larvae of Decapod Crustaceans*. Centre of Advanced Study in Marine Biology, Parangipettai, Tamil Nadu.

Silas EG. 1983. *Development of Penaeid Prawns*. CMFRI Bull. No. 28.

Saxena AB. 1996. *Life of Crustaceans*. Recent Advance in Entomology Series-10. Anmol Publ.

FRM 123 Aquatic Mammals, Reptiles and Amphibians 1 (1+0)

Theory

Selected aquatic mammal -**2 hrs**, reptile **1 hr**. amphibian and birds **1 hr.** species of India relevant to fisheries: taxonomic status, identification characters, distribution, abundance, habitat, exploitation, threats and conservation- **3 hrs**. Biology of aquatic animals: Cetaceans (whales. dolphins, porpoises and narwal)- **3 hrs**. Sirenia (manates and dugongs) **1 hr**. Carnivora (seals, sea lions walruses, polar bear and otter) -**2 hrs**.Sea turtles, tortoise, crocodiles, sea/freshwater snakes and amphibians -**3 hrs**. IUCN criteria – Red list, Wild Life (Protection) Act- **2 hr**s.

Suggested Readings

Conant, R. and J. T. Collins. 1991. A field guide to reptiles and amphibians of eastern and central North America, Third Ed. Boston: Houghton Mifflin Co. 450 pp.

Leatherwood, S., D. K. Caldwell and H. E. Winn. 1976. Whales, dolphins and porpoises of the western North Atlantic. N.O.A.A. Tech. Rep. National Marine Fisheries Serv. CIRC-396. 176 pp.

Levine, Emanuel, ed. 1998. Bull=s birds of New York State. Ithaca, NY: Cornell University Press

Wilson, Don E. and Dee Ann M. Reeder, eds. 2005. Mammal species of the world. A Taxonomic and Geographic Reference, Third ed. Johns Hopkins University Press, 2,142 pp.

FRM 211 Physiology of Finfish and Shellfish 3 (2+1)

Theory

Water as a biological medium. Water cycle, water as a habitat, physical and chemical properties of water and biological characteristics, biological importance as a solvent and as a medium for living organisms and as a cell constituent - **2 hrs.**

Respiratory system: Physiology of gas exchange and dynamics of oxygen and carbon dioxide transport in fin fsh. Gas exchange, transport and respiratory pigments in shell fish - **4 hrs.**

Digestive system: Mechanical and chemical aspects of digestion, digestive enzymes and their action, mechanism of absorption in fin fish and shell fish-**4 hrs.**

Circulation: Arterial and venous circulation in finfish. Haemoglobin polymorphism, Generalised pattern and constituents of blood in shell fish-**4 hrs.**

Excretion: Physiology of excretion in fish. Nitrogen excretion in shell fish- **4 hrs.**

Osmoregulation; osmotic and ionic regulation in fresh water, marine, brackish water and diadromous fishes. Osmoregulation in shell fish- **5 hrs.**

Reproductive physiology: Cellular mechanisms in development. Endocrine control of reproduction in fish and shell fish. Role of hormones, maturation promoting factor and prostaglandins- **5 hrs.**

Muscle physiology; Physiology of muscle contraction, countercurrent heat exchange system in tunas - **2 hrs.** Nervous system: Chemical basis of nerve impulse, synaptic transmission. Reflex action, stimulus-response chain in stickle backs, pheromones. Generalized pattern of nervous system in shell fish, giant neuron, neurotransmitters (eg. prawn, cephalopods)- **4 hrs.** Physiology of moulting in shellfish-**2 hrs.**

Practicals

Estimation of oxygen consumption, Osmoregulation, ammonia excretion and carbon-dioxide output. Influence of temperature and salinity on metabolism. Haematology of fin and shellfishes. Histological techniques.

Suggested Readings

Hoar, W. S. and Randall, D. J., (Eds.), *Fish Physiology*, Academic Press, New York, 101-187, 1978.
Wilson, R. P., Amino acids and proteins, in *Fish Nutrition*, 3rd Edition, Halver, J. E. and Hardy, R. W., Eds. Academic Press, Amsterdam, 2002, pp. 143-179.
Bartels, H., The gills of hagfishes, in *The Biology of Hagfishes*, Jorgenson, J.M., Lomholt, J. P., Weber, R. W. and Malte, H., Eds., Chapman & Hall, London, 1998, Chapter 13.
Bennett, M. V. L., Electric organs. In *Fish Physiology*, Hoar, W. S. amd Randal, D. J. (Eds.), Academic Press, New York, 1971, 346-491.

HRM 221 Marine Fisheries 3 (2+1)

Theory

Classification and definition of fishery zones and fishery resources of world: Important fishery regions of the world: North west Pacific, South east Pacific and North east Atlantic regions. Major fish and shell fish resources-**3 hrs.**

Overview of marine fisheries resources of the world and India: Major fisheries of the world-Peruvian anchovy,Alaskan Pollock, Japanese Pilchard, Atlantic herring, Oceanic tunas. International fishery commissions - **4 hrs.**

Major exploited marine fisheries of India, their developmental history and present status-**2 hrs.**

General aspects of the Indian Exclusive Economic Zone – the major fishing zones- the continental shelf and outer shelf region of each zone- characteristics, area potential and exploitation. Potential marine fishery resources of the India's EEZ-**3 hrs.**

Important pelagic fishery resources: Clupeoid resources- Indian oil sardine, lesser sardines white baits and other anchovies, other clupeids and wolf herring. Scombroid resources- Indian mackerel, seer fishes, tunas, bonitos, bill fishes and ribbon fishes-**5 hrs.**

Midwater resources- Bombay duck and carangid resources-**2 hrs.** Demersal resources: Elasmobranchs, sciaenids, silver bellies, pomfrets, other perches, cat fishes lizard fishes and flat fishes - **4 hrs.**

Crustacean resources- Prawns (penaeids and non penaeids), lobsters,crab-**4 hrs.** Molluscan resources- Mussels, oysters, clams, gastropods and cephalopods -**3 hrs.**

Seaweed resources – agarophytes, alginophytes, edible algae-**1 hr.** Deep sea and oceanic resources, island fisheries -**1 hr.** Fishery of wadge bank, mud bank fishery - **1 hr.** GIS and Remote sensing in marine capture fishery- **1 hr.** Exploratory and deep sea fishery surveys and estimation of potential yield and potential based on primary and secondary production - **2 hrs.**

Practicals

Visit to fish landing centres, Observation and analysis of catches by major crafts and gears. Field collection of fishes, crustaceans, molluscs and seaweeds and record keeping of relevant data. Participation in fishing cruises. GIS and remote sensing in marine capture fishery.

Suggested Readings

Jhingran VG. 1991. *Fish and Fisheries of India*. 3rd Ed. Hindustan Publ.
Kurian CV & Sebastian VO. 1986. *Prawns and Prawn Fisheries of India*. Hindustan Publ. Corp.
Peter BM & Joseph JC. Jr. 2000. *Fishes- An Introduction to Ichthyology*. 4th Ed. Prentice Hall.
Samuel CT. 1968. *Marine Fisheries in India*. Narendra Publ. House.
Shanbhogue SL. 2000. *Marine Fisheries of India*. ICAR.
Simon J, Kaiser MJ & Reynolds JD. 2001. *Marine Fisheries Ecology*.Blackwell.
Yadav BN. 1997. *Fish and Fisheries.* 2nd Ed. Daya Publ. House.

FRM 222 Inland Fisheries 3 (2+1)

Theory

FAO major inland fishing areas of the world and their major fisheries, Status and trends of global inland capture fisheries production- **hrs.**

Inland fisheries resources of India, Riverine fishery resources – Himalayan Rivers and Peninsular Rivers, Ichthyofauna of rivers, Fishery of major and minor carps, catfishes and other groups, Reservoir fisheries and their management, Flood plain capture fishery- Present status of exploitation and future prospects- **4 hrs.**

Estuarine fishery resources of India—residents and migrants, fishery of prawns, crabs, molluscs, mullets, clupeids, sciaenids, thread fins, perches and other groups, traditional fisheries like prawn filtration- 4 **hrs.**

Coldwater fishery resources of India- fishery of snow trouts, mahseer, carps and trouts - **1 hr.**

Fishery of brackishwater lakes- Chilka, Pulicat and Vembanad Lakes, present status of exploitation and future prospects- **3 hrs.**

Conservation and management of inland water resources –riverine and reservoir fisheries –ranching and establishment of sanctuaries-**3 hrs.**

Methodology for estimation of inland fish production in India and problems encountered-**1 hr.**

Practicals

Analysis of species composition of commercial catches at landing and assembling centers, sampling and familiarization of commercially important groups. Observations and experimental operations of selected fishing crafts and gears in inland / estuarine waters. Maintenance of records on catch data. Visit to Dept. of fisheries, lakes and reservoirs, net making yards.

Suggested Readings

Ayyappan et al., 2006. Handbook of Fisheries and Aquaculture. ICAR, New Delhi: 750 p.

Jhingran, V.G., 1991. Fish and Fisheries of India. Hindustan Publishing Corporation (India), Delhi. 727 pp.

Kaur, K. and A. Dhawan, 1997. Introduction to inland fisheries. National Agricultural Technology Information Centre, Ludhiana, India: 1-22

Misra, S.R., 2006. Inland fisheries in India - issues and concerns. Concept Publishing Company: 136 pp

Sugunan, V. V., 1995. Reservoir fisheries in India. FAO Fisheries Technical Paper No. 345. Food and agriculture Organization of the United Nations, Rome: 423 pp.

Welcome, R.L., 2007. Inland fisheries – Ecology and management. Discovery Publishing House, New Delhi: 358 pp

FRM 321 Fish Population Dynamics and Stock Assessment3 (2+1)

Theory

The concept of population and unit stock, Introduction, definition and concept- **3 hrs**. Biological structure of fisheries resource in space and time**.** Indicators of dynamics in a fishery resource. Characteristics of unit and mixed stock-**3 hrs**. Data requirements for stock assessment. Segregation of stocks. Principles of stock assessment. Population age structure. Theory of life tables-**3 hrs**. Von Bertalanffy growth parameters-**3hrs**. Graphical models. Monte Cario simulation model and ECOPATH model- **3hrs**. Estimation of total fishing and natural mortality **3 hrs**. The concept of yield, yield in number and yield in weight, yield per recruit, yield curve. Yield models. Trawl selection and gillnet selection. Eumetric fishing-**3 hrs.** CPUE, swept area method, Biomass, surplus production models-**3 hrs.** The concept of Maximum Sustainable Yield and Maximum Economic Yield. Biological symptoms of under-fishing and over-fishing-**3 hrs**. Growth over-fishing and recruitment over-fishing. Open access fisheries-**3 hrs**. Fisheries regulations -**3 hrs**. Analytical models of fish stocks - **3 hrs**.

Practicals

Study of length – weight relationship, segregation of stock using direct methods. Study of analytical models: Beverton and Holt model. VBGF, Pauly's integrated methods, graphical models. Estimation of Z, F and M. estimation of net selectivity coefficient. Fitting of surplus production model: Schaeffer model, Fox model. Study of yield isopleth diagrams. Micro-computer packages ELEFAN, FISAT.

Suggested Readings

Beverton RJH & Holt SJ. 2004. *On the Dynamics of Exploited Fish Population*. The Blackburn Press.

Gulland JA. 1977. *Fish Population Dynamics*. John Wiley & Sons.

Gulland JA. 1992. *A Review of Length Based Approaches to Assessing Fish Stocks*. FAO Tech. Paper No. 323, Rome.

Ricker WE. 1971. *Methods for the Assessment of Fish Production in Freshwaters*. Blackwell, Oxford & IBH.

Sparre P & Venema SC. 1998. *Introduction to Tropical Fish Stock Assessment*. Part 1 Manual. FAO. Fisheries Tech. Paper No. 301, Rome.

DEPARTMENT OF AQUATIC ANIMAL HEALTH MANAGEMENT

AAH 111 Fundamentals of Microbiology 3 (2+1)

Theory

Alexander Flemming, Joseph Lister, Winogrdasky -**1 hr**. Microscopy- Principle and construction of brightfield, dark field, phase contrast, stereo, SEM and TEM- **3 hrs**.

Microbial taxonomy –Bergy's and molecular taxonomy. Types of Microorganisms: Prokaryotes– Morphology and ultrastructure of bacterial cell. General features, types and importance of viruses, cyanobacteria, actinomycetes, archae, mycoplasma, rickettsiae. Eukaryotes – Diagnostic features and importance of fungi and protozoa -**3 hrs.**

Microbial Techniques - Types of media, types of sterilization - physical and chemical agents, cultivation of microorganisms, staining techniques – simple, differential, structural staining; enumeration of micro-organisms, culture preservation methods- **2 hrs**.

Bacterial metabolism: Nutrient requirements, nutritional types, bacterial photosynthesis and their ecological significance- **3 hrs.**

Microbial growth: Growth phases, measurement of cell growth, factors affecting growth-influence of physico-chemical factors - pH, temperature, moisture, light, osmotic pressure, fermentation - types and significance -**3 hrs.**

Microbial genetics- general principles, genetic recombination, transformation, transduction and conjugation.Plasmids- types and their importance. Mutation –types and significance- **4 hrs.**

Microbial ecology**:**Introduction and types of interaction,extremophiles and their significance -**3hrs.**

Aquatic Microbiology:Introduction and **s**cope of aquatic microbiology -**1 hr.** Aquatic environment as habitat for microorganisms - bacteria, cyanobacteria, fungi, algae, parasites and viruses -**3 hrs.** Distribution of microorganisms and their biomass in rivers, lakes, sea and sediment. Influence of physical, chemical and biological factors on aquatic microbes -**2 hrs.**

Microbial biofilms. Role of microbes in the production and breakdown of organic matter.Role of microbes in sedimentation and mineralization process -**4 hrs.**

Nutrient cycles-carbon, nitrogen, sulphur, phosphorus, iron, and manganese cycles. Sewage microbiology, self purification in natural waters, sewage treatment, drinking water microbiology, sanitary quality of water for aquaculture, bioremediators- **3 hrs.** Economic significance of aquatic microbes- **1 hr.**

Practicals

Handling of microscopes, Wet mount, smear and hanging drop preparations Micrometry-Determination of size of micro organisms (ocular, stage micrometers). Tools and techniques in sterilization methods:Filteration, dry heat, moist heat, chemical agents Cultivation technique: Media preparation, Isolation -pure culture, subculture. Observation of fungi, blue-green algae, and protozoans. Staining techniques for bacteria– simple, differential, structural and Biochemical tests: Indole, methyl red, Voges Proskauer, citrate test, oxidase test, catalase tests. Collection of water and sediment samples for microbiological analysis, Winogradsky cylinder, Isolation, identification and enumeration of various groups of microorganisms from different water bodies including aquaculture systems.

Study of bacteria involved in nutrient cycles. Biofilms, water testing for potability, enumeration of coliform. Antibiotic sensitivity of bacteria - antibiotic sensitivity test – disc diffusion method.

Suggested readings

Anna M.Romani., M. DolorsBalaguer and Helena Guasch(2016). Aquatic Biofilms: Ecology, water quality and treatment.

Chistopher.J.Woolverton., Joanne Willey and Linda Sherwood(2010). Prescott's microbiology.ISBN no- 978-19-1019-018-0.

Madigan.,Martinko., Stall and Cook(2010).Brock Biology of Microorganism.4th edition. ISBN no- 978-03-2164-963-8.

Vos,P., Garrity,G., Jones,D., Krieg, N.R., Ludwig,W., Rainey, F.A., Schleifer, K.H and Whiman,W.(2009). Bergey's Manual of Systematic Bacteriology. Volume-3.ISBN no-978-03-8768-489-5.

David Hendricks Bergey(1923). Bergey's Manual of Determinative Bacteriology.

AAH 221 Fish and Shellfish Pathology 3 (2+1)

Theory

Significance of finFish and Shellfish diseases in aquaculture -**1 hr.** Host, Pathogen and Environment Interaction- **3 hrs.** Disease development process -**1hr.** Stress in aquaculture and its role in disease development- **3 hrs.** Terms and definitions in pathology- **1 hr.** Pathological processes: Cellular response to injury- **1 hr.** Inflammatory response to diseases-**2 hr**s. Pathogencity mechanism of parasite, bacteria, virus and fungus -**8 hrs.** Case history and clinical signs in disease diagnosis- **4hrs.** Role of physical (injuries, health, cold) chemical (pH, salinity, toxins, ammonia, nitrogenous waste, endogenous chemicals and metabolites, free radicals, oxidants) soil and water parameters in fish health -**6 hrs.** Nutritional diseases- **4 hrs.** Non-infectious diseases- **2 hrs.**

Practicals

Live and post mortem examination of fish and shellfish. Pathology of organ systems. Histopathology of normal and diseases fish and shellfish, Diagnosis of abiotic fish diseases.

Suggested readings:

Carl J.Sidermann(2009). Principal diseases of marine fish and shellfish.Volume-2.2nd edition.ISBN no-012-645851-0.

K.P.Biswas(2000).Prevention and control of fish and prawn diseases.2nd edition.ISBN no-81-85375-59-3PB.

B.Austin(2012).Infectious diseases in Aquaculture, prevention and control.ISBN no-978-0-85709-016-4.

V.Ramachandran(2013)Fish Pathology.ISBN no-978-93-82036-31-9.

Wilhelm Schaperclaus (1989) Fish Diseases. ISBN no-81-7087-056-9(Volume-1)
ISBN no-81-7087-056-7(volume-2).

Ronald J. Roberts(2012). Fish Pathology.4th edition.ISBN no-978-14-4433-282-7.

AAH 222 Pharmacology 3 (2+1)

Theory

Introduction to Pharmacology: History, Importance, Terms and Definitions -**2 hrs.** Drug development, Screening and Nomenclature -**3 hrs.** Scope of pharmacology in fishes -**1 hr.**
Route of Administration and Method of application to fish -**1 hr.** Source of Drugs- **4 hrs.** Pharmacolotherapeutic classification of drugs-**2 hrs.**
Pharmacokinetics: Biological membrane, absorption, distribution, biotransformation and Excretion of drugs -**3 hrs.** Factors influencing drug metabolism -**1 hr.**
Pharmacodynamics: Principles of drug action, concept of drug receptor, nature, chemistry, classification. Functions of receptor. Transducer mechanism, second messenger, non receptor mediated action. Dose Response Relationship, half life withdrawal period, potency, efficacy, threshold dose, therapeutic dose, maximal dose, toxic dose, lethal dose- **6 hrs**.

Factors modifying drug action , Adverse drug effects, drug interaction and Bioassay of drugs- **4 hrs**.
Salient features in drug acting on digestive system, nervous system and cardiovascular system- **5 hr**s. Drugs used in fish transporation -**1 hr.** Recent advances in Pharmacology, biostatistics in experimental Pharmacology-**2 hrs** Pharmaceutical industry- **1 hr**.

Practicals

Introduction to Pharmacy, Metrology, Prescription Writing, Preparation of drug solution, Source and chemical nature of drugs, Incompatability, Pharmacutical technology, Bioassay of drugs, Animal models in Pharmacological experiments, Methods of application of drugs in fish.

Suggested readings:

Morris H.Baslow(1969). Marine Pharmacology.2nd edition.ISBN no- 0-88275-470-X.
RosamundM.Baird., Norman A. Hodges and Stephen P. Denyer.(2000)Handbook of microbiological quality control in Pharmaceuticals and medical devices.ISBN no-0-748-40614-X.
Jennifer Danielson(2014). Essential of Pharmacology.ISBN no-978-0-76383-870-6.
Francesco Clement and Guidofumogalli(2015).General and molecular pharmacology, Principles and Drug action.ISBN no-978-1-118-76859-4.
K. M Treves - Brown. (2000)Applied Fish Pharmacology, Kluwer Academic Publishers.

Boyce P. Wanamaker and Kathy Lockett Massey (2014).Applied Pharmacology for Veterinary Technicians Vth Edition.
Gregory A. Lewbart (2009). Fish Medicine Handbook

AAH 311 Microbial and Parasitic Diseases of Fish and Shellfish 3 (2+1)

Theory

General characteristics, life cycle, diagnosis, prevention and treatment of : parasitic (**4 hrs**), bacterial (**4 hrs**), fungal (**2 hrs**) and viral (**4 hrs**) diseases of finfish. General characteristics, life cycle, diagnosis, prevention and treatment of: bacterial (**2 hrs**), viral (**2 hrs**), parasitic and fungal (**2 hrs**) diseases of shellfish. OIE listed diseases Disease surveillance and reporting -**2 hrs.**
Quarantine and health certification in aquaculture -**1 hr.** Health management strategies in Aquaculture: Vaccines, Immunostimulants, Bioremediation, Probiotics, Crop rotation, Good and Best management practices- **4 hrs.** SPF and SPR stocks –development and application -**1 hr**.
Bio-security principles, Sanitary and phytosanitary Agreement- **1 hr.** Disease control through environmental management -**1 hr.** Importance of Biofilm, Biofloc, Periphyton in Aquatic Health Management, Zoonotic diseases- **2 hrs**. Principles of disease diagnosis, conventional, molecular and antibody based diagnostic methods, Rapid diagnostic methods - **4 hrs**.

Practicals

General procedure for disease diagnosis. Methods of sampling fish and shellfish for disease diagnosis. Taxonomy, lifecycle and identification of fish and shellfish parasites .Sampling, preparation of media and culture of pathogenic bacteria: Techniques for bacterial classification. Techniques in disease diagnosis: Microbiological, haematological, Histopathological, immunological, molecular techniques and Biochemical tests. Agglutination test; Challenge tests; purification of virus; Stress related study of fish and shellfish; Disease treatment.

Suggested readings:

Patrick T.K.Woo and Kart Buchmann(2012). Fish parasites: pathology and protection. Volume-13.ISBN no-978-18-4593-806-2.

Charles M. Hendrix and Ed.Robinson(2011).Diagnostic Parasitology for Veterinary Technicians.4th edition.ISBN no-978-03-2307-761-3.
Ronald J. Roberts(2012). Fish Pathology.4th edition.ISBN no-978-14-4433-282-7.
P.T.K.Woo and Bruno,D.W(2011). Fish Diseases and Disorders.2nd edition, volume-3. ISBN no-978-18-45593-554-2.
Galina Jeney(2017). Fish Diseases, Prevention and Control Strategies.1st edition.ISBN no-978-01-2804-564-0.
B.Austin and D.A. Austin.(2012).Bacterial fish pathogen and diseases in farmed and wild fish.ISBN no-0-470-70765-5.

AAH 312 Fish Toxicology 2 (1+1)

Theory

General Toxicology: Definitions, Branches of Toxicology, Historical developments-**1hr**. Classification of poison -**1 hr**. Types of poisoning- Toxicity testing - Chronocity factor, Untoward effects, Common causes, Diagnosis of poisoning, Factors modifying toxicity, Toxicokinetics, Toxicodynamics, General approaches to diagnosis and treatment of poisoning- **6 hrs**.

*Systemic Toxicology:*Toxicity caused by metal and non-metals -**1 hr.** Phytotoxins- Toxic principles of various alkaloids and toxic plants- **2 hrs.** Drug toxicity and toxicity caused by agrochemicals -**2 hrs.** Mycotoxins, Bacterial toxins- **1 hr.** Collections and dispatch of specimens in Toxicological cases-**1 hr.**

Toxicity of drugs in Aquaculture: Maximum Residual Limits (MRL) of various drugs and chemicals in fish- **1 hr.** Metabolism of toxic substances by aquatic organisms -**2 hrs**.

Practicals

Detection of heavy metal poisoning. Spot tests for metals. Group reaction for metals- Arsenic, Antimony, Lead (Pb), Mercury (Hg), Zinc (Zn), Barium (Ba), Iron (Fe_3^+), Copper (Cu), Ammonia (ammonium ions) NH_4^+ Chloride (Cl^-), Phosphate ($P0_4$) Sulphate ($S0_4$) Flouride (Fl^-), Qualitative detection of Nitrite and Nitrate, Detection of hydrocyanic acid, Detection and Estimation of Mycotoxins, Test for detection of alkaloids, Estimation of LD_{5O} and ED_{5O} Demonstration of drug toxicity.

Suggested readings

Richard T. Di Giulio and David E.Hinton (2008).The toxicology of fishes.ISBN no- 978-04-1524-868-6.

Peter G. Well., Kennaeth Lee and Christian Blaise(1997). Microscale testing in aquatic toxicology- Adavnces, Techniques and Practices.ISBN no- 978-08-4932-626-4.

Keith Tierney., Anthony Farrell and Collin Brauner (2013). Organic Chemical Toxicology of fishes. Volume-33, 1st edition, ISBN no-978-01-2398-254-4.

T.Braunbeak., D.E. Hinton and B. Streit (2012).Fish Ecotoxicology.ISBN no-978-30-3489-802-7.

AAH 321 Fish Immunology 2 (1+1)

Theory

Introduction, brief history to immunology- **1 hr.** Defense mechanism in finfish - Types of immunity: Innate and adaptive immunity, cell mediated and humoral immunity- **3 hrs.** Ontogeny of immune system, cells and organs of the immune system- **1 hr.**

Antigens – structure and types. epitopes, haptens -**1hr.** Antibody – fine structure, classes with structure and functions, antigenic determinants on immunoglobulins -**1 hr.** MHC complex – types, structure, and functions.Antigen-antibody interactions- principle, antigen recognition by B-cells and T cells- **1 hr.** Antigen-antibody reaction - Precipitin reactions, agglutination reactions- **1 hr.**

Defense mechanism in shellfish- **1 hr.** Sources of infection, transmission of disease producing organisms, Immunity to bacteria, virus, fungi, and parasites -**2 hrs.** Role of stress and host defense mechanism in disease development -**1 hr.**

Vaccines - types of vaccines – whole cell vaccine, purified macromolecules, recombinant – vector, DNA vaccines and multivalent subunit vaccines, modes of vaccine administration -**2 hrs**.
Serological methods in disease diagnosis -**1 hr.**
Immunostimulants –types, mechanism of action, modes of administration- **1 hr.** Immunoassays, immunodiffusion, ELISA, immunofluorescence, neutralization, radioimmunoassay, serotyping - **1 hr**.

Practicals

Collection, separation and identification of fish leucocytes. Separation of blood plasma and serum. Differential counting - RBC and WBC by Haemocytometer. Study of different types of leukocytes and isolation of macrophages. Precipitin reactions - Agglutination test,immunogel diffusion, double immuno diffusion, radial immuno diffusion assay, ELISA. Methods of vaccine preparation and techniques of fish immunization.

Suggested readings:

Margaret J.Manning and Mary F. Tatner(1983). Fish immunology.ISBN no-0-124-69230-3.
George Iwama and TeruyukiNakanish (1996).The fish immune system- organism, pathogen and environment.
Jonne S stolen.,T.C.Flecher., D.P. Anderson., B.S. Robinson and W.B Van Muiswinkal(1990). Techniques in fish immunology.
P. Swain., PramodakumarSahoo and S.Ayyappan(2009). ISBN no- 978-81-8537-591-5.
P. Swain, P. K. Sahoo and S. Ayyappan (2006). Fish and Shellfish Immunology: An Introduction, NarendraPublishing House
Ronald J. Roberts(2012). Fish Pathology.4th edition.ISBN no-978-14-4433-282-7.

AAH 322 Therapeutics in Aquaculture 2 (1+1)

Theory
Scope and current scenario of therapeutics in aquaculture- **1 hr.** Chemotherapy: History, definition, terms used and classification of AMA -**2 hrs.**
Antibacterial agents, mode of action, general principles, classification -**2 hrs.** Antibiotics, different classes and their mode of action, properties etc. Antibiotic resistance, Antibiotics used in aquaculture -**5 hrs.**
Antiseptics and disinfectants -**1 hr**. Antiparasiticides: Ectoparasites, Endoparasites and Protozoanes- **1 hr**.
Biologics: Immuno-stimulants and Vaccines-Principles in preparation/formulation, mechanism of action. Drug formulation for aquaculture-Principles in preparation/formulation, mechanism of action, drug leaching, stabilizer, binders and dosage -**2 hrs**.

Therapeutants in aquaculture: Classification, pesticides, fungicides/ algicides, hormones, anaesthetics, flesh color enhancers -**2 hrs.** Chemicals of therapeutic value, Law priority aquaculture drugs -**1 hr**. Drugs used for structural material and substances for maintenance, substances connected with zoo technical practices, list of the drugs used in aquaculture with therapeutics -**1 hr.**

Practicals

Regulations of drug use. Introduction to antimicrobials, preparation of potassium permanganate solution, preparation of weak Tincture Iodine. Minimum inhibitory concentration(MIC). Five-plate screening test for the detection of antibiotic residue. Calculation of different disinfectants dosage in treating fish ponds. Generic name, patent name, dosage and indications of various aquaculture drugs used in fish health.

Suggested readings

Claude E. Boyd and Craig. S. Tucker (1998). Pond Aquaculture water quality management. ISBN no- 0-412-07181-9.

K. Gopakumar and A.D.Diwan(2010). Coastal Aquaculture and Aquaculture management.ISBN no-978-93-80428-14-7.

T.Lakshmi Prasad and K. Ramaswamy(2014).Sustainable Aquaculture.ISBN no-978-81-8342-330-4.

Tomas G Villa and ParticiaVeiga-crepso(2009).Enzybiotics –Antibiotic enzymes as drug and therapeutics. ISBN no-978-0-470-37655-3.

Claudia Harper and Christian Lawrence (2010). The Laboratory Zebrafish, a volume in the Laboratory animal pocket reference series

DEPARTMENT OF AQUATIC ENVIRONMENT MANAGEMENT

AEM 111 Meteorology, Climatology and Geography 2 (1+1)

Theory

Nature of Atmosphere: weather and climate; composition of atmosphere; structure of atmosphere - **2 hr**. Heat energy of atmosphere: process of heat transmission; heating of atmosphere; disposal of insolation**;** irregular heating of atmosphere - **1 hr**. Temperature: Temperature instruments; periodic, horizontal and vertical temperature variations; effects of vertical air motion on temperature **- 1 hr**. Humidity and water vapour: relationship between temperature and humidity; distribution of water vapour in atmosphere; evaporation, humidity instruments and measurements- **1 hr**. Condensation and precipitation: process of conditions of condensation, forms of condensation; precipitation; forms of precipitation, measurement of precipitation; rainfall in India - **1 hr**. Clouds and thunderstorms: amount of cloudiness; ceiling; classification of clouds; conditions of cloud formation; reporting and identification of clouds; thunderstorms - **2 hr**. Atmospheric pressure: meaning of atmospheric pressure; the laws of Gases; pressure units; pressure instruments; vertical, horizontal and periodic variations; isobars and pressure gradients- **hr.** Wind: characteristics of wind motion; wind observation and measurement; wind representation; factors affecting wind motion. Terrestrial or planetary winds: ideal planetary wind system; planetary pressure belts - **hr**. Secondary winds; monsoon winds; land and sea breeze - **2 hr**. Tropical cyclones: storm divisions; pressure and winds; vertical structure of storm centre; hurricane, sea, swell and surge; hurricane warning - **hr**. Weather forecasting: forecasting process; forecasting from local indications; role of satellite in weather forecasting; synoptic weather charts - **hr**. Effects of climate change on fisheries sector-**1 hr**. Introduction to Geography: shape, size and structure of the earth; concepts of latitude, longitude and great circles; model globe, maps and different types of projections; cartography; landscape
1 hr.

Practicals

Graphic representation of structure of atmosphere; physical layering and compositional layering. Temperature instruments: simple thermometers; Six's Max-Min Thermometer; thermograph. Isotherms: world mean temperatures-January to July. India mean temperatures - January to July. Humidity measurement: hygrometer; psychrometer; relative humidity; dew point. Condensation: observation and identification of various types of clouds. Depicting sky picture. Precipitation: measurement of rainfall using rain gauge. Mapping Indian monsoons: south-west monsoon and rainfall in June, North-east monsoon and rainfall in December; isohyets. Atmospheric pressure measurement: fortin's mercurial barometer; Aneroid barometer. Isobars: India mean pressure - Jan to July. Windobservation and measurement: wind vane; cup anemometer. Ideal terrestrial/planetary pressure and wind systems: diagrammatic representation. Geography: The Earth: diagrammatic representation of shape, size, structure, zones, latitudes, longitudes and

great circles. Typical landscape mapping; map reading. Geographical terms used in landscape.

Suggested readings

Barry, R. G. and Charley, R. J . 1981	Atmosphere, Weather and Climate (E.L.B.S & Methuen& Co. Ltd.)
Battan ,L. J. 1979	Fundamentals of Meteorology (Prentice- hall Inc. , N .J.)
Blair, T. A. and Fite, R .C. 1969	Weather elements (Prentice - hall Inc. N.J.)
Das , P. K. 1996	The monsoons (National Book trust, India)
Donn, W. L. 1975	Meteorology(McGraw- Hill Book Company, New York)
Menon, P. A. 1989	Our weather (National Book Trust, India)
Menon , P.A. and C.K. Rajan 1989	Climate of Kerala(Classic Publishing House, Cochin)
Meteorological Office 1978	Meteorology for Mariner's (HMSO, London)
Petterssen, S. 1969	Introduction to Meteorology (McGraw - Hill Book Company, New York)
Richl,H. 1978	Introduction to Atmosphere (McGraw- Hill Kogakusha Ltd. ,Tokyo)
Trewartha,G,T. 1968	An Introduction to climate (McGraw - Hill Inc. New York)
Cotter,C.H. 1966	The Astronomical and Mathematical foundations of Geography (Hollis& Carter, London)
Hagget,P. 1979	Geography - A modern synthesis (Harper & Row Publishers, New York)
Mcintyre, M P 1973	Physical Geography (Ronald Press Company, New York)

AEM 112 Soil and Water Chemistry3 (2+1)

Theory

Analytical chemistry: principles, applications and types. Classical methods of analytical chemistry, volumetry and gravimetry. Solutions: Standard solutions - primary and secondary standards , examples , Acid - base titrations, indicators, units of concentration- Normality, Molarity, Molality and ppm, standard curve; nomograph. (**7 hours**).

Concepts of Acids and base, types of slats- acidic, basic, neutral salts, pH, buffer solutions - types. Henderson Equation. (**3 hrs**)

Chemistry of water: the water molecule, properties of pure water, fresh water and sea water. Composition of waters**:** surface water, ground water and sea water. Water pollution - sources and effects. (**4 hours**).

Water analysis - sampling and preservation, Measurement of temperature. transparency, turbidity, pH, electrical conductivity, salinity, chlorinity, total dissolved solids , dissolved oxygen, total alkalinity, total hardness, Inorganic Nitrogen (Ammonium, nitrite and Nitrate) and phosphate. Water Quality Standards , Water quality criteria/ requirements for Aquaculture. (**6 hours**)

Soil Chemistry: origin and nature of soils. Physical properties of soil - soil colour. texture, soil horizon , structure, pore size, bulk density, water holding capacity. Soil types and their distribution. (**4 hours**)

Soil chemistry: soil colloids, Cation exchange capacity , organic carbon, labile and refractory organic compounds in soil - humic acids, fulvic acids , Carbon - Nitrogen ratio, soil fertility, micro and macro nutrients . Soil reactions : acidity, alkalinity, conductivity, redox - potential. Submersed soils: wet lands, peat soils, Saline soils, Alkali soils, acid sulphate soils, iron pyrites, soil reclamation. (**6 hours**)

Soil analysis: Sampling, preservation and preparation of soil samples. Determination of soil texture, water holding capacity, pH, conductivity, organic carbon, nitrogen, phosphorus, lime requirement and gypsum requirement. (**3 hours**)

Soil amendments: lime manures, fertilizers, micronutrients, zeolites, alum, gypsum. Environmental ameliorative: chlorination, deodorizers, bacterial formulation. Soil quality criteria/ requirements for aquaculture. (**3 hours**)

Practicals

Principles of Titrimetry, Gravimetry, Potentiometry, Conductometry, Colourimetry, Spectrophotometry (UV-Visible) .

Demonstration: Demonstration of laboratory glass wares and equipment used in water and soil analysis.

Water analysis: measurement of temperature, turbidity, determination of pH and EC.

Determination of salinity, Chlorinity, Total solids, Redox potential, DO, Determination of total alkalinity, hardness. Determination of ammonium, nitrite and phosphate (Colorimetric)

Soil analysis: Determination of soil texture, soil pH, soil available nitrogen, available phosphorus, and organic carbon.

Selected Readings

American Public Health Association — Standard Methods for the Examination of Water and Waste

American Water Works Association
Water Environment Federation 1998 — Water (1998 20 th Ed.)

Bassett J Denny R C , Jeffery G H and Mendhanm J 1978	A text Book of Quantitative Inorganic analysis- The English Language Book Society and Longmans
Jackson M L 1973	Soil Chemical Analysis – Prentice – Hall of India Pvt. Ltd
Werner T Stumm and Jammes J Morgan 1970	Aquatic Chemistry – John Wiley and Sons Inc.

AEM 121 Limnology 3 (2+1)

Theory

Introduction to limnology (**1 hour**). Inland water types, their identities and distribution; ponds and lakes; streams and rivers. (**2 hours**). Dynamics of lentic and lotic environments; Influence of physical and chemical conditions on living organisms in inland waters (**2 hours**).

Ponds: physical, chemical and biological conditions; production and decomposition (**2 hours**). Streams: physical, chemical and biological conditions. (**2 hours**). Lakes: their origin and diversity. Famous lakes of the world and India; nature of lake environment; morphometry, physical and chemical conditions and related phenomena; biological relations (**2 hours**).

Plankton: planktonic organisms; classification and plankton; distribution of plankton: geographic, vertical, horizontal and seasonal distribution of phytoplankton and zooplankton: seasonal changes of body form in planktonic organisms; food of planktonic organisms. (**4 hours**)

Concepts of productivity: measurement of primary productivity, trophic levels and examples, ecological pyramids, biogeochemical cycles – patterns and basic types, cycling of organic nutrients; pathways, limiting factors and governing laws (**4 hours**).

Aquatic plants: character, classification, zonation, seasonal relations, quantity produced, distribution in different waters, limnological role(**2 hours**). Nekton: composition, distribution, movements(**2 hours**). Benthos: classification; periphyton; zonation; distribution; movements and migration; seasonal changes in benthos, profundal bottom fauna (**3 hours**).

Biological productivity: circulation of food material. (**3 hours**)

Classification of lakes based on productivity; laws of minimum ;biotic potential and environment resistance ; quantitative relationships in a standing crop;trophic dynamics;successional phenomena; indices of productivity of lakes; artificial enrichment. (**3 hours**)

Lotic environments: running water in general ;physical conditions; classification of lotic environments,biological conditions; productivity of lotic environments; influence of currents;plant growth; plankton; nekton; benthos; temporary and head waters sterams;ecological succession. (**4 hours**).

Practicals

Morphometry of lakes, ponds and streams. Determination of physical characteristics of lentic water bodies. Determination of chemical characteristics of lentic water bodies. Determination of physical characteristics of lotic water bodies. Determination of chemical characteristics of lotic water bodies. Collection and identification of fresh water phytoplankton. Enumeration and biomass estimation of freshwater phytoplankton. Estimation of primary productivity in fresh water bodies. Collection and identification of fresh water zooplankton. Enumeration and biomass estimation of fresh water zooplankton. Collection and identification of benthos from lakes and ponds, streams and canals. Collection and identification of nekton/aquatic insects from freshwater bodies. Collection and identification of aquatic plants from different fresh water bodies. Field visit to lotic and lentic water bodies.

Selected Readings

Hutchinson,G.E. 1957	A Treatise on Limnology (I & II) - John Wiley& Sons Inc. New York.
Jhingran V G,1991	Fish and Fisheries of India, Hindustan Publishing Corporation, New Delhi
Macan T.T 1973	Ponds & Lakes , George Allen& Unwin Ltd. London
Tonapi G.T.1980	Freshwater Animals of India , Oxford & IBH Publishing Co., New Delhi
Welch P.S. 1952	Limnology - McGraw - Hill, New York
Wetzel R.G., 1975	Limnology - W. B. Saunders Company , Philadelphia

AEM 122 Marine Biology 3 (2+1)

Theory

Introduction to the subject; Divisions of marine environment-pelagic, benthic, euphotic, aphotic divisions and their subdivisions. (**3 hours**)

Life in oceans-general account of major groups of phytoplankton, seaweeds, major zooplankton groups, benthic invertebrates. (**5 hours**)

Nekton: outline composition of nekton, habitats of nekton (**2 hours**)

Environmental factors affecting life in the oceans; salinity, temperature, light, currents, waves, tides, oxygen and carbon dioxide. (**4 hours**). Primary, secondary and tertiary production, estimation methods (**3 hours**)

Marine food chains and food webs (**2 hour**). Vertical migration of zooplankton; Phytoplankton-Zooplankton relationship, geographical and seasonal variation in plankton production, plankton and fisheries; Bioluminescence and indicator species. Red tides. (**3 hours**)

The seashore: The Intertidal zone, factors affecting life on shore, nature of substratum, physical factors, zonation fauna and flora on a rocky shores, sandy shore and muddy shore. (**5 hours**)

Estuaries –classification; physic-chemical factors; biota and productivity; example of some Indian estuaries (**2 hours**). Boring and fouling organisms. (**2 hours**).

Classification and Ecology of marine reptiles, birds and mammals (**2 hours**).

Mud banks; Mangrove –flora and fauna; coral reefs-flora and fauna. (**3 hours**)

Practicals

Study of common instruments used for collection of phytoplankton, zooplankton and benthos. Collection, preservation and analysis of phytoplankton, zooplankton, sea weeds, Collection preservation and analysis of inter tidal organisms.

AEM 211 Fishery Oceanography 2(1+1)

Theory

Introduction to Oceanography: classification; expeditions national and international **1 hr**

Ocean basin - Major feature of topography and terminology; major divisions. Indian Ocean and its subdivisions, EEZ. General oceanographic features of Arabian Sea and Bay of Bengal **2 hrs**

Ocean Waves: definition and terms; classification, Difference between surface and long waves; wave theories; surface wave generation; spreading growth; Beaufort Scale; spilling and breaking waves; long waves, Tsunamis, internal waves **2 hr**s

Ocean Tides: Definition; Tidal phenomenon, elementary tidal definition; tidal inequalities; tide producing forces types of tides tidal bores, tide prediction **2 hr**

Ocean Currents: Definitions and features; measurements of currents; direct and indirect methods, drift currents, Ekman spirals, upwelling, sinking, gradient currents; thermohaline circulation; characteristics; course; and significance of some major ocean currents of the world. El-Nino **3 hr**

Physical properties of sea water: Salinity and chlorinity; density,temperature; SST, thermal properties of sea water; colligative and other properties of sea water; Residence time of constituents in seawater. Properties of sea ice; transmission of sound; absorption of radiation; diffusivity and viscosity **3 hrs.** Spatial and temporal variations in temperature and

salinity in the ocean.T-S diagram; water masses of Indian oceans **1 hr.**

Chemistry of sea water: Constancy of composition; elements present in sea water; artificial sea water; dissolves gases in sea water **2 hr**s. Distribution of phosphorus, nitrogen compoundsandsilicates in the oceans, factor influencing their distribution**2 hrs.**

Practicals

Field visits and operation of oceanographic instruments- Nansen reversing water sampler, Bathythermograph, Grabs, Corers, Current meters, Tidal gauges, Echo-sounder. Measurement of temperature, Transparency, pH. Determination of DO, Salinity, Ammonia, Nitrate, Nitrite, Phosphate and Silicate in sea water

Selected Readings

American Public Health Asociation	Standard Methods for the Examination of Water and Waste
American Water Works Association Water Environment Federation	Water (1998 20 th Ed.) – APHA
Cappuro L. R.A. 1970	Oceanography for practicing Engineers, Barns& Nobles Inc. N.Y.
David A Ross 1977	Introduction to Oceanography, Prentice Hall Inc. pp.
Drake C.L. Imbrie J. Knauss, J.A.,Turekiran, K.K. 1978	Oceanography - Holt Rinahart & Winston N. Y.
Gerry Bearman(Ed) 1989	Seawater; its composition properties and Behaviour . The Open University / Pergamon Press, Oxford.
Indian Standard Institution Effluents Bureau	Methods of Sampling and tests of Industrial of Indian Standards
Knauss J. A. 1978	Introduction to physical oceanography . Prentice Hall, New Jersey
Millero, F.J. and Sohn, M.L. 1991	Chemical Oceanography, CRC Pres, USA
Pickard, G.L. 1976 ed.	Descriptive physical oceanography, Pergamon Press, Oxford
Pipkin,B. W. ,Gorsline D. S. , Casey R. E. ,Hammon D.E. 1977	Laboratory exercises in oceanography , W. H. Freemann& Co. San Francisco
Riley J. P. and Chester R. 1973	Introduction to Marine Chemistry , Academic Press
Sarma R. S. and Vittal M. 1980	Oceanography for geographers, Allahabad
Sverdrup H.U., Johnson M. W. and Fleming R.H. 1970	The Ocean, Prentice - Hall Inc.
Sverdrup H.U., Johnson M. W. and	The oceans their physics,chemistry and general

Fleming R.H. 1970	biology,Prentice Hall Inc. pp.
Weihaupt J. G. 1979	Exploration of the ocean - An introduction to oceanography - Macmillan Publishing Co. , N.Y.

Suggested readings

Jeffrey Levinton, 2011	Marine Biology- Function, Biodiversity, Ecology, Oxford University Press
Peter Castro and Michael E Huber, 2008	Marine Biology, 8th Edition, McGraw Hill International Edition
Carol M. Lalli and Timothy R Parsons, 2006	Biological Oceanography- An Introduction, 2nd Edition, Elseviers
Holne,N.A. & Melntype A.D. 1971	Methods for the study of marine benthos - IBP Handbook No. 16 Blackwell Scientific Publication, Oxford and Edinberg
Nair, N. B. and Thampy D, M. 1980	A Text Book of Marine Ecology, Macmillan Company of India, New Delhi
Newell G. E. & Newell R.C. 1977	Marine Plankton - A practical guide , Hutchinson& Co. London
Nybakken J. W. 1982	Marine Biology - An ecological approach Harpex & Row, New York
Ross D. A. 1977	Introduction to Oceanography Prentice Hall Inc. N.J.
Russell F.S. and Yonge C M 1975	The Seas Frederic Warne & Co. Ltd. New York
Sverdrup H.U., Johnson M. W. and Fleming R.H. 1942	The oceans their physics, chemistry and general biology, Prentice Hall Inc. N.J.
Wickstead J.H. 1965	An Introduction to the study of Tropical Plankton , Hutchinson

AEM 212 Aquatic Ecology, Biodiversity and Disaster Management 3 (2+1)

Theory

Introduction to Aquatic ecology: Definition, Ecological hierarchy, Subdivisions of Ecology, Ecosystem: Principles and concepts (**2 hour**).

Types of interaction: animal association-symbiosis, commensalisms, parasitism, prey-predator relationship, host-parasite relationship (**2 hours**).

Ecological niches – lagoons, estuaries, mangroves, coral reefs, flood plains, coastal wet lands, bheels, oxbow lakes. (**3 hour**). Ecological Indicators: Community Ecology: Ecological Dominance: patterns in communities, ecotones, Population ecology: Population group properties, population density, Autoecology: Concepts of Habitat and ecological Niche; Natural Selection; Artificial Selection (**3 hours**).

Aquatic biodiversity: its importance, species diversity, genetic diversity, habitat diversity, diversity indices (**2 hours**). Threats to biodiversity –habitat destination, introduction of exotic species. Conservation of habitat, fish passes for migratory fishes, protected areas, marine parks and sanctuaries, mangrove afforestation. Artificial reefs (**3 hours**).

Conservation programmes for endangered species, *ex situ* and *in situ* conservation, captive breeding and management of endangered species. Various national and international conventions and regulations concerning biodiversity, including use of selective gears and exclusion devices (**3 hours**)

Disaster Management in Fisheries: Basic concepts: Hazard, risk, vulnerability, disaster, capacity building. Multi-hazard and disaster vulnerability of India **2 hr**.

Types of natural and manmade hazards in fisheries and aquaculture - cyclones, floods, droughts, tsunami, El-nino, algal blooms, avalanches, pollution, habitat destruction, over fishing, introduction of exotic species, landslides, epidemics, loss of bio-diversity etc. **2 hr**

Causes, characteristics and effects of disasters. Management strategies: pre-disaster, during disaster and post-disaster **2 hr**.

Pre-disaster: prevention, preparedness and mitigation; different ways of detecting and predicting disasters; early warning, communication and dissemination, community based disaster preparedness, structural and non-structural mitigation measures **2 hr**.

During disaster: response and recovery systems at national, state and local, coordination between different agencies, international best practices **2 hr**.

Post-disaster: Methods for assessment of initial and long term damages, reconstruction and rehabilitation. Prevalent national and global management practices in disaster management **2 hr**.

Agencies involved in monitoring and early warnings at district, state, national and global levels **1 hr**.

Sea safety and health. Acquaintance with fire-fighting devices. Life saving appliances and first-aid **2 hr**. Uses of distress signals and technologies. Relief and rehabilitation measures, trauma counseling **2 hr**.

Practicals

Collection of species of fishes and other organisms and studying the assemblages of organisms of rocky, sandy and muddy shores, lentic and lotic habitats. Observation of adaptive characters and interrelationships like commensalisms, symbiosis, parasitism and predation. Field visits to mangroves, marine parks, sanctuaries, coral reefs, rivers, hills, streams, lakes and reservoirs. Working out biodiversity indices.

Suggested readings

Agrawal K.C. 1999	Biodiversity . Agro Botanica , Bikaner
Elliot A.N. (Ed.) 1993	Global Marine Biological Diversity Island Press, Washington D. C.
Groombridege D.M. 1992	Global Biodiversity: Ststus of the Earths Living Resources Chapman and Hall , London
ICAR (2006)	Handbook of Fisheries and Aquaculture
Takuya Abe et al. (Eds.) 1977	Biodiversity - An ecological perspective Springer Verlag, New York

AEM 311 Coastal Zone Management 2 (1+1)

Theory

Coastal Zone Management – Need, benefits, principles, and objectives. Coastal zone management in India- **2 hr**.

Coastal Regulation Zone (CRZ) Act, Coastal regulation zones and their importance for main land and islands – Environmental policies, planning, administrative and regulations. CRZ mapping. Integrated Coastal Zone Management (ICZM) - concept, application and case studies **3 hr**

Application of Remote Sensing and Geographical Information System (GIS) for Coastal Management. Applications of GIS in aquatic resource identification and mapping **2 hr**

Living and – Non - living resources of coastal zone **2hr**

Importance and role of coastal ecosystems such as mangroves, coral reefs seagrasses, estuaries, wet lands, lagoons and coastal plantation in coastal protection. Coastal protection measures **2 hr**

Multiple uses of the coastal zone - urban settlement, industrial development, waste disposal, ports and marine transportation,land transportation infrastructure, water supply projects, fisheries, aquaculture and tourism **2 hr**

Impacts of human activities on coastal and ocean areas: Challenges related to climate change, expanding tourism, declining fisheries, intensive shipping and biodiversity protection. Problems related to sectors such as tourism and fisheries in the ICZM context. Coastal Pollution **2 hr**.

Environmental Impact Assessment (EIA): History, Principles and process, evaluation and methodology. EIA of coastal aquaculture projects **2 hr**

Disaster management for coastal environment **1 hr**

Practicals

Field visit to different coastal environments to study erosion of beaches, Identification of ecologically sensitive areas and protection, Study of CRZ, ICZM along the coastal belt, Study on implementation and violation of CRZ, Study of application of remote sensing and GIS, Project preparation of EIA.

Suggested readings

Gilbert Barnabe and Regine Barnabe - Quet (2000)	Ecology and management of Coastal waters - The Aquatic Environment (Springer - Praxis Books in Aquaculture Series)
Govt. of India (1998)	The Gazette of India - Extraordinary Part II Section 3 - Subsection (ii) No. 756
John R. Clark (1995)	Coastal Zone Management - handbook , CRC Press, Florida , USA
John R. Clark(1977)	Coastal Ecosystem Management -(John Wiley and Sons, New York)

AEM 321 Aquatic Pollution 2 (1+1)

Theory

Introduction to aquatic pollution, the sources of pollutants, toxic organic compounds and their impacts in the aquatic organisms and the abiotic environment **2 hr.**

Classification of pollution- physical, chemical and biological classification of water pollution- description of terminologies **1 hr**. Sewage and domestic wastes- composition and pollution effects- sewage treatment and its reuse **2 hr**.

Agricultural wastes- organic detritus, nutrients, Adverse effects of oxygen demanding wastes: importance of dissolved oxygen; Oxygen demand; BOD; COD; Oxygen budget **1 hr**;

Biological effects of organic matter **1 hr**.

Excessive plant nutrients: Eutrophication; Red tides and fish kills. Pesticide types and categories; inorganic pesticides, Organo-chlorine compounds, Organo-phosphorous compounds; Polychlorinated biphenyls (PCBs) **1 hr**;

Bioaccumulation and impact on aquatic fauna and human health; toxicology. Heavy metals: Interaction of heavy metals with water and aquatic organisms **1 hr**.

Bioremediation and Phytoremediation. Oil pollution; Crude oil and its fractions **1 hr**;

Sources of oil pollution; Treatment of oil spills at sea; Beach Cleaning; Toxicity of Petroleum Hydrocarbons **1 hr**;

Ecological Impact of Oil pollution- Case studies **1 hr**.

Microbial pollution: Types of aquatic microbes; autotrophs and heterotrophs; saprotrophs and necrotrophs; Sewage Fungus Complex; Transmission of Human Pathogenic Organisms; Zoonosis; Development of Antibiotic Resistance and its impact **2 hr**; Biofilms and Biocorrosion **1 hr**;

Radioactivity and background radiation of earth: Radionuclide polluting, special effects of radioactive pollution **1 hr**.

Thermal pollution and its effects, Physical and chemical nature of possible effluents from major industries in India. Monitoring and control of pollution: Biological indicators of pollution **1 hr**.

Solid waste management **1 hr**.

Practicals

Physical characteristics of polluted waters; Colour, Odour, Turbidity. Determination of pH, salinity, alkalinity, hardness, BOD, COD, Hydrogen sulphide, Phosphates, Ammonia, Nitrates, Heavy metals and Oil and grease in water. Determination of pH, conductivity, organic carbon, nitrogen, phosphorus, heavy metals in sediments. Study of pathogenic and coliform bacteria. Bacteriological quality of water; Colliform tests, IMVIC test, standard plate count, methods of enumerating bacterial biomass in waters and waste waters. Pollution flora and fauna: indicator species- algae, protozoa and insect larva. Methods of pesticide residue analysis in waters and fish tissue; bioassay and toxicity study.

Suggested readings

American Public Health Association	Standard Methods for the Examination of Water and Waste

American Water Works Association Water Environment Federation	Water (1998 20 th Ed.) - APHA
Clark R B, (2001)	Marine Pollution (5 th Ed.) Oxford University Press, New York
Indian Standard Institution Effluents Bureau	Methods of Sampling and tests of Industrial of Indian Standards
Sverdrup H.U., Johnson M. W. and Fleming R.H. 1970	The Ocean, Prentice - Hall Inc.
Riley, J P. and Chester R. 1973	Introduction to Marine Chemistry, Academic Press
Sebastian A., Gerlach (1981)	Marine Pollution - Diagnosis and Therapy , Springer - Verlag, Heidelberg

DEPARTMENT OF FISH PROCESSING TECHNOLOGY

FPT 121 Fish in Nutrition 1(1+0)

Theory

Composition of fish with emphasis on nutritional value-**2 hrs**. Concept of Biological value -**1 hr**. Protein Efficiency ratio, Net protein utilization.Amino acids of fish and shellfishes and importance of essential amino acids -**3 hrs**. Fish lipids: fatty acids, nutritional quality. Role of fish lipids in human nutrition-**3 hrs**. Non-protein nitrogen substances in fishes-**2 hrs**. Vitamins in fish: water soluble, fat soluble, significance in human nutrition-**2 hrs**. Minerals in fish: micro- and macro-elements, trace elements, significance in human nutrition- **1 hr**. Other functional bio-molecules in fish – peptides, collagen and squalene- **2 hr**.Effect of different kinds of cooking fish ie.curry, frying, steaming, smoking, fermentation on nutrition value-**2 hrs**.

Suggested Reading

1. Swaminathan,M. 1974*. Essentials of food and nutrition*. Volume **I**. Fundamental aspects-Ganesh & Company, Madras p.576.
2. Gopakumar K.(Ed.). 2002. *Textbook of fish processing technology* ICAR, New Delhi.
3. Simpson D.S. 1987. *Food Biochemistry and Nutritional Value*. Longman
4. Jnsel P, Turna RE and Ross D. 2001. *Nutrition.* Jones and Bartlet.
5. Maurice E. Stansby.(Ed) .1990. Fish Oils in Nutrition. An AVI Book. Published by Van Nostrand Reinhold. New York.
6. Borderias A.J, Colmenero J.F, and Tejada M. 1985. Viscosity and emulsifying of fish and chicken muscle protein. J. food Technol. 20, 31- 42.
7. Shewan J.M. 1951. The chemistry and metabolism of the nitrogenous extractives in fish. *Soc. Symposia* (Cambridge Engl.) No. 6, 28-48.
8. Love R. M, Lovern J.A and Jones N.R. 1959. The chemical composition of fish tissues. *Gt. Brit.Dept. Sci. Ind. Research, Food Invest. Spec. Rept.*69, 62 p.

FPT 211 Food Chemistry 3 (2+1)

Theory

Composition of food and nutritional value. Moisture in foods -**2 hrs**. Biological oxidation, electron transport chain, P/0 ratio; oxidative phosphorylation- **3 hrs**. Carbohydrates: Naturally occurring polysaccharides in foods. Seaweed polysaccharides – sources and uses. Browning reactions – enzymatic and non-enzymatic- **4 hrs**. Lipids: metabolism of lipids, oxidation of fatty acids, lipoproteins; VLDL and HDL and their importance- **3 hrs**. Proteins: metabolism, deamination, decarboxylation, metabolic fate of amino acids, nitrogen balance. Deamination reactions and nitrogen excretion with special reference to fish. Fish muscle proteins, chemical changes in muscle during contraction. Proteins in foods, role in hydration- native and denatured proteins, gel formation, functional properties of proteins, changes during heat treatment and processing, texturised proteins- **5 hrs**. Chemistry of taste, flavour and odour components in foods, flavour intensifiers, synthetic flavouring substances- **4 hrs**. The taste of fish and shellfish- **2 hrs**. Food additives - types and their chemical nature, emulsifiers and antimicrobial additives, sequestrants,

flavourpotentiators surface active agents- **2 hrs**. non-nutritive sweeteners, colour additives in food -**2 hrs**. Assessment of quality of food by instrumental and chemical methods. Nutritive value of foods- **3 hrs**. Energy value and energy requirements and their estimation- **2 hrs**. Water, electrolytic and acid-base balance. Nutritive value of proteins PER, BV digestibility coefficient, NPU values, pepsin digestibility- **2 hrs**. Role of fibre in human nutrition- **2 hrs**.

Practicals

Estimation of moisture, crude protein, fat, ash (including acid soluble) in fish sample. Determination of energy value of fish. Estimation of glucose and salt content in foods. Colorimetric method of estimation of proteins and carbohydrates. Use of pH meter. Estimation of freshness quality indices such as TVBN, TMA, alpha-amino nitrogen, PV, FFA, TBA value of fish. Estimation of fibre in foods.

Suggested Reading

1. Fennema , O.R(Ed.) 1976. *Principles of food science* . Part **I**- Food chemistry. Morcel Dekker Inc. New York. P.792.
2. Simpson D.S. 1987. *Food Biochemistry and Nutritional Value*. Longman
3. Gopakumar K.(Ed.). 2002. *Textbook of fish processing technology* ICAR, New Delhi.
4. Govindan. T.K . 1985. *Fish processing technology*. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi P.252.
5. Ira G.Garard.1976. *Introduction to food chemistry*. The AVI Publishing company, Inc .West port, connectient p.312.
6. Suzuki.T.1981. *Fish and Krill protein: processing technology*. Applied Science Publishers Ltd., London. P.260.
7. Sen DP.2005. *Advances in fish processing technology* . Allied publ.

FPT 212 Freezing Technology 2 (1+1)

Theory

Introduction to freezing technology -**1 hr**. characteristics of fish and shellfish; changes in fish after death, spoilage of fish, spoilage and pathogenic microorganism **-2hrs**. Handling of fresh fish; sanitation in processing plants- **2 hrs**. Principles of low temperature preservations. Chilling of fish – methods and equipment for chilling; icing – quality of ice, ice making; refrigerated or chilled sea water, chilling rate; spoilage of fish during chilled storage -**3 hrs**. use of antibiotics and chemical **- 2 hrs**. Freezing of fish fundamental aspects; heat units; freezing point depression, eutectic point; freezing rate; methods of freezing, freeze drying, physico– chemical changes that occur during freezing, mechanism of ice crystal formation; preparation of fish for freezing -**4 hrs**.

Changes that occur during frozen storage – microbiological, physical and chemical changes, protein denaturation, fat oxidation, dehydration, drip; protective treatments – polyphosphate,

glazing, antioxidants, packaging; thawing of frozen fish – methods of thawing- **2 hrs**. Transportation of frozen fish, cold chain, quality control, HACCP in freezing industry- **2 hrs**.

Practicals

Sanitation and plant housekeeping; chilling and freezing equipment, instruments; packages and product styles; methods of icing fish; cooling rate; preservation by chilled sea water; freezing and thawing curves; freezing of different varieties of fish and shellfish; estimation of drip; determination of quality changes during frozen storage; inspection of frozen fishery products; visits to ice plants, cold storages and freezing plants.

Suggested Reading:

1. Balachandran, K. K (2001). Post-harvest Technology of fish and fish products. Pub. Daya Publishing House, Delhi.
2. Cleland C Andrew, 1990. Food Refrigeration Processes, Elsevier Applied Sciences, London
3. Clucas, I.J., 1981. Fish Handling, Preservation and Processing in the Tropics: Part I. FAO.
4. Clucas, I.J., 1981. Fish Handling, Preservation and Processing in the Tropics: Part II.FAO
5. Fennema,K., Powrie W.D. and Marth, EH 1973.Low Temperature Preservation of Foods and Living Matter," Marcel Dekker , New York .
6. Fennema, O. R. (editor) Principle of Food Science., Publ. Marcel Dekker Inc. NewYark
7. Gopakumar K. (editor), 2002. Text Book of Fish Processing Technology. ICAR, New Delhi .
8. Hall G. M. (Ed), Fish Processing Technology (1992), Blackie Academic and Professional, London
9. Regenssein, J. M. and Regenssein, C. E., 1991. Introduction to fish technology. Van : Nostrand Reinhold, New York
10. Sen D. P., 2005. Advances in Fish Processing Technology. Allied Publishers Pvt. Ltd. New Delhi.
11. Rudolf, K, 1969. Freezing and irradiation of fish. Fishing News (Books) Ltd., London.

FPT 221 Fish Canning Technology 2 (1+1)

Theory

Introduction to canning and its historical developments- **1 hr**. Advantages of canning in relation to other preservation methods- **1hr**. Raw materials and sub materials, their characteristics and suitability for canning-**1 hr**. Classification of foods based on pH, commercial sterility, Absolute sterility, pasteurisation and sterilization- **2 hrs**. Canning process, process flow steps involved HTST and aseptic canning -**2 hrs**. General steps in canning procedure and importance, preparation of raw material, packing, pre-cooking, exhausting, seaming, retorting, cooling labelling and storage-**1 hr**. Principles of thermal processing. Heat resistance of micro organisms, heat penetration studies, mechanism of heat transfer- **2 hrs**. Cold spot and its importance, convection and conduction type of packs. Process calculation by general/ graphical methods, estimation of Fo value of the process (D-value, Z-Value TDT, F-value, lethal rate)- **1 hr**. Commercial sterilization, 12-D concept- **1 hr**.

Canning of commercially important fin fishes, shell fishes and cephalopods-**1 hr**. Spoilage of canned foods, types, causes and preventive measures- **1 hr**. Quality standards, plant layout, hygiene and sanitation and waste disposa- **2 hrs**. Types of packaging materials for canned foods, metal containers (Tin Plate, TFS, Aluminium cans) and retortable pouches- **2 hrs**.

Practicals

Typesofcans,canningequipmentsandlayoutofcannery.Canningof different varieties of fish and shell fish. Cutout test of canned products. Examination of candouble seam. Heat resistance of bacteria. Heat penetration in canned food, thermal process calculation by general method. Study of spoilage condition in canned products. Familiarization with various packaging materials and container for fish products.

Suggested Reading

1. Balachandran, K.K., Fish Canning Principles and Practices. CIFT, Cochin.
2. Gopakumar K., 2002. Text Book of Fish Processing Technology. ICAR, New Delhi .
3. Hall, G.M., 1992. Fish Processing Technology (Ed), Blackie Academic and Professional, London. Hersom, A. C and Hulland, E. D, 1980. Canned Foods. Chemical Publishing Company, Inc., New York. Larousse, J and Brown, B. E, 1997. Food Canning Technology. Willey VCH New York.
4. Stumbo, 1973.Thermo Bacteriology in Food Processing. C.RC ,Academic Press, New York.
5. Thorne, S. 1991. Food Irradiation. Elsevier Applied Science, London.
6. Venugopal, V. 2006. Seafood Processing. Taylor & Francis Group, London.
7. Warne, D., 1988.Manual on Fish Canning. FAO Fisheries Technical paper 285.
8. Zeathen, P. 1984. Thermal processing and quality of foods. Elsevier Applied Science Publishers. London.

F P T 2 2 2 Fish Packaging Technology 2 (1+1)

Theory

Introduction to packaging, Importance of packaging in fish processing, functions, objectives and requirements -**2 hrs**. Packaging materials, basic and laminates-**1hr**. principles of their manufacture and their identification- **2 hrs**. Properties of packaging materials and their use in protective packaging with special reference to food-**1 hr**. Printing for packaging and print identification- **1hr**. Closures of packaging, heat seals bottle closure. Principles of packaging fresh produce handling and transportation. Packaging for retail sale and storage. Packaging equipment and machinery-**1 hr**.

Package design, evaluation and testing. Flexible packaging materials, rigid containers, thermoform containers, glass containers, corrugated fiber boards, duplex cartons, edible packaging materials- **3 hrs**. Laminations and co-extrusions- **1 hr**. Retort pouch packaging - advantages and disadvantages- **1 hr**. Biodegradable films, vacuum packaging, active packaging, MAP, Polymeric Packaging.Packaging requirements of fresh fish, Frozen fish- **2 hr**s.

Canned Fish. Transport worthiness of packaging materials, accelerated shelf testing.Materials and their safe use in food contact application. Safety and legislation aspects of packing- **2 hrs**. Labeling and bar coding -**1 hr**.

.

Practicals

Determination of grammage of paper and board, bursting strength, burst factor, punctures resistance, water proofness, stiffness of the board, ring stiffness of paper and board, flat crush, tensile strength and elongation at break of plastic films, density of plastic films, breaking length, impact strength of plastic films, tearing strength of paper and plastic films, water vapour transmission rate, oxygen transmission rate, heat seal strength, suitability of plastic films for food contact applications, evaluation of retort pouch, identification of plastic films.

Suggested Reading

1. Balachandran, K.K. 2001. Post Harvest Technology of Fish and Fish Products. Daya Publishing House. New Delhi.

2. Gopakumar. K, 1993. Fish Packaging Technology – Materials and Methods. Concept publishing Co., New Delhi.

FPT 311 Quality Assurance of Fish and Fishery Products 3 (2+1)

Theory

Quality dimensions of seafood – sensory, intrinsic, quantitative and affective parameters-**2 hrs**. Pre-harvest and post harvest factors affecting quality-**1 hr**. Assessment of quality changes in fresh and iced fish. Quality changes during processing**2 hrs**. Importance of quality, definitions and terminologies-**1 hr**.

Application of HACCP concept in surveillance and quality assurance programmes for raw, frozen, canned, cured, irradiated, cooked and chilled, modified atmosphere packaged and freeze dried products-**4 hrs**.

Risk assessment, principles of plant hygiene and sanitation, pest control, personnel hygiene, planning and layout, equipment construction and design-**2 hrs**. Food laws and standards, national and international legislation, mandatory and non mandatory standards-**2 hrs**.

Role of export inspection council & export inspection agency and MPEDA in fish and fishery products-**2 hrs**. Executive instructions on fish and fishery products, Legislation for export quality assurance in India **-2hrs**.

Certification system for fish & fishery products-**1 hr**. Legal basis for monitoring products related EU requirements-**2 hrs**. Scheme for approval and monitoring of establishments/factory vessels/ freezer vessels processing/storing fish & fishery products for expor-**1 hr**. Complaint handling procedure on fish and fishery products-**1hr**. Interpretation of test reports and limits on chemical residues-**1 hr**. GoI notifications on fish and fishery products-**1 hr**.

General requirements for export of fish and fishery products to the EU. International regulatory framework for fish safety and quality-**2 hrs**.

Prerequisites to HACCP, Labelling for product traceability and Labelling requirements-National and international, legislation on labelling, components of traceability code-nutrition facts and nutrition labelling, specific requirements of nutrition labelling, food meant for specific age group and convalescing people-**3 hrs**.

EU legislation on traceability of fish and fish products, Assessment of food safety programmes- **1hr**.

The HACCP for seafood industries and protection of food from adulterants.Standards for sea foods.FSSA, FDA, ISO.Use of additives in seafood processing as quality enhancers-**2 hrs**. Seafood safety, authenticity, traceability.Waste management in seafood processing-**2 hrs**.

Practicals

Assessment of quality of fresh fish by sensory, biochemical, and instrumental methods. Chlorination and Hardness estimations. Quality analysis of canned, frozen, cured and pickled fish products. Quality tests for tin and corrugated containers. Assessment of plant, equipment sanitation and personnel hygiene. Detection of filth and extraneous matter in traditional processed products.

Suggested Reading

1. Fernandes R. 2009.*Microbiology hand book fish and seafood*. Leatherhead Food International Ltd. United Kingdom
2. Bremner H A.2002. *Safety and quality issues in Fish Processing*. Cambridge, Woodhead Publishing Ltd.
3. Iyer ,TSG,Kandoran M.K, Mary Thomas and Mathew ,P.T.(Eds) 2002.*Quality Assurance in sea food processing* ,CIFT, Kochi.
4. US Food and Drug Administration. 1998*. Fish and Fishery Products Hazards and Controls Guide.* Rockville, Food and Drug Administration.
5. Bonnell A.D. 1994. *Process control, in Quality assurance in Sea food processing: A practical Guide* . Ed. Bonnell A.D. London, Chapman and Hall, 39-53.
6. Hall GM. (Ed). 1992. *Fish processing technology*. Blackie Academic and professional , London
7. Huss HH, Jakobsen M& Liston J.1991, *Quality assurance in the fish industry*. Elsevier publishing, London, New York.
8. John DEV. 1985. *Food safety and toxicity*.CRC press, New York ,London ,Tokyo .Sea food science and technology – BLISH.
9. Krenzer R.1971. *Fish inspection and quality control*. Fishing News
10. Connell.J.J.1975. *Control of fish quality fishing.* News Books Ltd.p.179.

FPT 321 Fish Products and Value Addition3 (2+1)

Theory

Principle of fish preservation and processing -**1 hr**. Processing of fish by traditional methods– salting, sun drying, smoking, marinading and fermentation- **2 hrs**. Theory of salting, methods of salting–wet salting and dry salting-**1 hr**. Drying and dehydration- theory,importance ofwater activity in relation to microbial growth- **2 hr**. Sun drying and artificial drying- solar dryer- **1 hr**.

Packaging and storage of salted and dried fish- **1hr**. Different types of spoilage in salt cured fish- **2 hrs**. Quality standard for salted and dryfish-**2 hrs**. Fish preservation by smoking-chemical composition of wood smoke and their role in preservation- **2 hrs**. Methods of smoking and equipments used for smoking **2 hr**. Carcinogenic compound in wood and methods to remove them - **2hrs**. Hurdle technology in fish preservation and processing-**2hrs**. Marinaded and fermented fish products – role of acids in marinades, Fish and prawn pickles, fish sauce and Fishpaste, traditional Indian fermented products **2 hrs**. Fermented fish products of South-east Asia -**2 hrs**.

Principles and methods of preparation of various fish paste products like fish sausage, fish ham, surimi, fish cake, kamaboko etc- **2 hrs.** Fish musclestructure, myofibrillarprotein and their role in elasticity formation **2 hrs**. Extruded products – theory of extrusion, equipments used, advantages of extruded products, methods of preparation of extruded products- **2hrs**. Value addition- **2 hrs**.

Diversified fish products: battered and braided products– fishfinger, fishcutlet, fishwafer, and fish soup powder,etc. and imitation products -**1 hr**. HACCP in safe products production -**3 hrs**.

Practicals

Preparation ofsalted fish, dried fish and smoked fishbydifferent methods. Quality assessment of salted, dried and smoked fish. Preparation of prawn & fish pickles. Preparation of fermented fish sauce and marinaded products. Preparation of surimi and surimi based products. Preparation of diversified and value added fish products. Quality assessment of market sample of dried and fermented fish products.

Suggested Reading

1. Balachandran, K.K., 2001. Post Harvest Technology of fish and fish products. Daya Publishing House, Delhi.
2. Gopakumar K. (editor), 2002. Text Book of Fish Processing Technology. ICAR, New Delhi .
3. Hall, G.M., 1992. Fish Processing Technology (Ed), Blackie Academic and Professional, London.
4. Sen D. P., 2005. Advances in Fish Processing Technology. Allied Publishers Pvt. Ltd. New Delhi. Wheaton and Lawson,1985. Processing Aquatic Food Products, By John Wiley and Sons New York. Windsor, M. and Barlow,1981. Introduction to Fishery Byproducts, Fishing News (Books) Ltd, London.

FPT 322 Microbiology of Fish and Fishery Products 3 (2+1)

Theory

Introduction and history of microorganisms in foods-**1 hr**. Role and significance of microorganisms in nature and in foods-**2 hrs**. Sources and types of microorganisms in fish and fishery products-**2 hrs**. Factors (intrinsic and extrinsic) affecting the growth and survival of microorganisms in food-**3 hrs**.

Enumeration of microorganisms in food by conventional and rapid techniques-**3 hrs**. Microbial principles of fish preservation and processing by application of low temperature, high temperature, drying, irradiation and chemicals-**4 hrs**. Microbiology and spoilage of fresh, semi processed and processed fish and fishery products-**4 hrs**.

Indicators of microbiological quality of fish and fishery products-**3 hrs**. Food borne pathogens involved in infective and intoxication type of food poisoning – *Vibrio cholerae, Vibrio parahaemolyticus, E. coli, Salmonella, Listeria monocytogenes, Clostridium botulinum, C. perfringens, Campylobacter and Staphylococcus aureus* – their occurrence, growth, survival, pathogenicity and prevention-**6 hrs**.

Other biological hazards associated with fish and fishery products- marine toxins-shellfish toxins, scombroid toxins, ciguatera toxins and puffer fish toxins; mycotoxins-**5 hrs**. parasites and viruses-**3 hrs**.

Practicals

Sampling and processing of samples for microbiological investigation. Enumeration of microorganisms associated with finfish, shellfish, water and ice. Testing of water for potability. Isolation and identification of pathogenic bacteria associated with fish and fishery products - *Vibrio cholerae, Vibrio parahaemolyticus,*, *E coli*, *Salmonella*, *Listeriamonocytogenes* and faecal streptococci. Biochemical tests for characterization of bacteria. Molecular methods for the detection of pathogenic microorganisms. Determination of MIC and MCC of chemical preservatives.

Suggested Reading

1. Modern Food Microbiology. 6th Edition. 2000. J. M. Jay. Chapman & Hall, New York.
2. Fundamental Food Microbiology. 2nd Edition. 2000. B. Ray. CRC Press. New York. USA.
3. Laboratory techniques for Microbiological examination of Seafood Fourth Edition By P.K. Surendran, Nirmala Thampuran, V. Narayan Nambiar, K.V Lalitha, Toms C. Joseph
4. *Microbiology Handbook Fish And Seafood (3rd) Jun 2009 Edited by Rhea Fernandes*
5. *International Commission on Microbiological Specifications for Foods. Fish and fish products (Microorganisms in fish products), in Microorganisms in Foods 6: Microbial Ecology of Food Commodities. Ed. International Commission on Microbiological Specifications for Foods. New York, Kluwer Academic / Plenum Publishers. 2005, 174-249.*
6. Food Microbiology. 2nd Edition. 2000. M.R. Adams and M.O. Moss. Royal Society of Chemistry, Cambridge.

FPT 323 Fish By-Products and Waste Utilization 2 (1+1)

Theory

Fish meal-**1 hr**. Dry reduction and wet reduction methods – specification – packaging and storage -**2hrs**. Fish oil – body oil – liver oil – extraction – purification – preservation – storage – application- **2hrs**. Shrimp wastes – chitin – chitosan-production – uses- **2 hrs**.

Fish protein concentrate-**1hr**. Fish hydrolysate, partially hydrolyzed and deodorized fish meat, functional fish protein concentrate and their incorporation to various products **-3 hr**. Fish silage – acid silage – fermented silage – application- **2 hrs**. Fishmaws, shark leather, fish glue,fish gelatin, isinglass, pearl essence, sharkfinrays, beach-de-mer-**2 hrs**.

Biochemical and pharmaceutical products -**2 hrs**. Utilization of seaweeds: agar agar, algin, carrageenan -**1 hr**.

Practicals

Preparation of fish meal, fish body oil, fish liver oil, fishmaws, isinglass, fishsilage, ensilage, fishglue, fishgelatin, fattice, pearl essence, chitin, chitosanand fishmanure Preparationof acid and fermented silage. Preparation of fish protein concentrate and fish hydrolysate.

Suggested Reading

1. Balachandran, K.K., 2001. Post Harvest Technology of fish and fish products. Daya Publishing House, Delhi.
2. Gopakumar K. (editor), 2002. Text Book of Fish Processing Technology. ICAR, New Delhi .
3. Hall, G.M., 1992. Fish Processing Technology (Ed), Blackie Academic and Professional, London.
4. Sen D. P., 2005. Advances in Fish Processing Technology. Allied Publishers Pvt. Ltd. New Delhi. Wheaton and Lawson,1985. Processing Aquatic Food Products, By John Wiley and Sons New York. Windsor, M. and Barlow,1981. Introduction to Fishery Byproducts, Fishing News (Books) Ltd, London.

DEPARTMENT OF FISHERIES ENGINEERING

FET 211 Refrigeration and Equipment Engineering 3 (2+1)

Theory

Fundamentals: Force, work, power, energy, volume, pressure, temperature. Heat, specific heat, sensible heat, latent heat, comparison between heat and work-A path function **1 hr**. Thermodynamics: Laws of Thermodynamics, Laws of perfect gases, Thermodynamic processes, Application of First and Second law of Thermodynamics in refrigeration, Thermodynamics cycle, entropy, enthalpy **1 hr**.

Refrigeration: History of refrigeration, Definition, principle, classification, Types of refrigeration systems i.e., Air refrigeration, vapour absorption refrigeration system. Vapour compression refrigeration system **2 hr**. Refrigeration plant: Layout of refrigeration plant, Construction. Insulating materials used for the cold storage construction, Frozen product storage capacity of cold storage, usage of Ante-room **2 hr**.

Refrigeration systems: Vapour compression refrigeration system advantages and disadvantages as compared toother refrigeration systems, Types of Vapour compression refrigeration cycles i.e., Theoretical Vapour compression refrigeration cycle, Actual refrigeration cycle **2 hr**.

Compressors: Definition, Types of compressor, construction, working principle advantages and disadvantages **2 hr**.

Evaporator: Definition, Types of Evaporator, construction, working principle advantages and disadvantages **2 hr**.

Condenser: Definition, Types of Condenser, Cooling Towers, construction, working principle, advantages and disadvantages **2 hr**.

Expansion valve: Definition, Types of Expansion valve, construction, working principle advantages and disadvantages **2 hr**.

Refrigerant: Primary refrigerant, secondary refrigerant, properties, ideal refrigerant, leakage detection **2 hr**. Study of auxiliary equipment: Receiver, oil charging, refrigerant charging, gas purging, oil draining, types of defrosting **2 hr**.

Ice-plant: Ice plant planning Brine tank construction, preparation of brine ,Types of ice, Storing of ice, Equipments used in ice plants **2 hr**.

Freezers: Definition, Design and construction of freezers i.e. Plate freezer, Blast freezer, Tunnel freezer, spray or immersion freezers, refrigerated fish rooms and fish hold. Alternative refrigeration technique arrangements used onboard the fishing vessel i.e., Refrigerated sea water (RSW), Chilled sea water (CSW). Refrigerated transport **2 hr**.

Cooling load: Unit of refrigeration, coefficient of performance (C.O.P),Refrigeration effect, study and use of Psychometric chart. Cooling load estimation, introduction, components of cooling load, heat gain through walls, roofs, products, occupants, lighting equipments**2 hr**.

Theory of machines: Transmission of power, friction wheels, shaft , gears, belt and Chain drive. Study of equipments used in fish processing with particular reference to canning, sausage, freeze drying and irradiation **2 hr**.

Maintenance: Definition, Types of maintenance, general maintenance of freezing plant, cold storage and ice plant **2 hr**.

Practicals

Drawing of Refrigeration and Fish processing machineries plant layout, Graphically represented symbols used in refrigeration, Handling and operation of compressors, condensers, evaporators expansion valves, low and high pressure switches. Study of auxiliary equipments: Receiver, oil charging, refrigerant charging, gas purging, oil draining, types of defrosting. Power transmission line diagram of different fish processing machineries. Visit to processing plant refrigeration plant, Visit to ice plant, Visit to fishing harbor to study the fish hold, refrigerated fish rooms. Calculation on refrigeration effect and cooling load.

Suggested readings

Domkundwar Arora. 2002, :A Course in Refrigeration and Air conditioning, Dhanpat rai & Co, ISBN: 9780000229663, 0000229660

Khurmi, R.S & J .K Gupta.2015, :Textbook of Refrigeration And Air Conditioning, S.Chand

Prasad, Manohar 2015 :Refrigeration and Air Conditioning, New Age International Pvt.Ltd., New Delhi.

Sreekrishna.Y and Shenoy, L. 2001 : Fishing Gear and Craft Technology, ICAR,New Delhi

FET 221 Navigation and Seamanship 2(1+1)

Theory

Principles of navigation –terms and definitions, finding positions and method of position fixing magnetic Compass-parts and functions, cardinal, inter cardinal, three letter and lay pointspelorus and azimuth mirror, method of observation **2 hrs**.

Sextant -parts and functions, finding adjustable and non adjustable errors and principles and use **1 hr**.

Hand lead line –construction and markings and method of taking soundings **1 hr**.

Types of speed logs –patent log, impeller log, Types of marine charts, Mercator and gnomonic projections great circles and rumba lines, chart collections and chart readings, chart observation and fixing positions **2 hrs**.

The IALA-buoy age systems, cardinal and lateral marks, meaning of shapes, colours and lights top marks and explanation of approaching, international code of signals, flag signals mars code and storm signals general system, brief system and extended system, storm signals stations Indian coasts, Fog signals, types and methods **2 hrs** .

Distress signals, methods, types and communication international regulations for preventing collision at sea and recognition of lights and shapes at sea. Observation of radar and parts and functions of radar, aneroid barometer, parts and functions of echo sounder, and sonar, observation of GPS **2 hrs**

Principles of seamanship- Causes fire at sea, fire prevention on board the vessel and method of fire fighting at sea and recommended fire fighting appliances,**1 hr**

Life saving appliances –life jackets, life buoys and method of operations and contents, SART and EPIRB **1 hr**.

Observations of storms, formation of storms and method of locating the eye of the storms and method of escaping from the center of the storms as per buys ballet law.Preparing vessel to face heavy weather **2 hr**.

Temporary repairs for leaks constructions of steering system and rigging emergency jury rudder .types of anchors and their applications. selection of suitable anchorage , procedure for anchoring anchor watch and procedure to combating dragging of anchor, method of standing moor and running moor, open moor berthing procedures, axial thrust , transverse thrust mooring and securing the vessel to the jetty rigging fenders and gangways , and method of leaving vessels from the berth **2 hr**.

Practicals

Anchoring, coming along side the berth and leaving, practicing the different types of knots and wire splices, use of magnetic compass, GPS, Echo-sounder. CHART WORK-Finding positions by latitudes and longitudes by position lines by cross bearing, horizontal sextant, angles, vertical sextant angle and by running fix, finding position by speed, distance and time findings set and drift of current and findings course made good speed made good and steering course and finding position by counter acting the current observation of RADAR

Suggested readings

Gerry Smith, 1977 : Coastal Navigatioin, a programmed learning course. Paul Elek,London 182p

Hepherd, 1973 : Small Boat Navigation. Stanley Paul, London 184p

Howell,F.S. 1977. : Navigation Primer for Fisherman, Fishing News Books Ltd.England 182p

John,V.Noel, 1977. : Modern Seamanship, Van Nostrand Reinhold Company, New York 676p

Kemp and Young,1977 : Seamanship Notes, Stanford Marine Limited,London, England

Kemp and Young,1977 : Notes on Compass work(Rev), Stanford Marine Limited,London, England 111p

Sreekrishna, Y. and Shenoy Latha. 2001 :Fishing gear and craft technology. Indian Council of Agricultural Research, New Delhi, 342p.

FET222. Fishing Gear Technology 2 (1+1)

Theory

Development fishing gears and Fishing Technology: Evolution of Fishing gears; Mechanization of Fishing; Basic classification of fishing gears- Principle, Subsidiary and Auxiliary gears. Classification of fishing gears and methods: FAO classification of fishing gear and methods of the world; International Standard Statistical Classification of Fishing gear (ISSCFG) **2 hr**.

Fishing gear materials: Natural materials and Synthetic netting materials and their classification. Types and important synthetic materials used in fishing gears. Raw-materials for synthetic material; Preparation of nylon (PA 6.66) material; Different types of fibres- continuous fibre; monofilament, staple and split fibers and production of single yarns. Identification of synthetic

fishing gear materials: Visual observation, water test, solubility test, burning test and melting point test **3 hr**.

Construction of twisted netting materials: Yarn, single yarns, folded yarns, netting twine, cable netting twine and cable netting twine of higher order; Construction of ropes and their higher order; construction of braided netting twines. Yarn numbering system - direct system: Tex system Denier system and calculation of resultant tex value. Indirect system : British count, metric count, runnage system and their conversion. Methods of Preparation of knotted and knotless webbing;, advantage and disadvantages of knotted and knotless webbings. Shape of mesh: diamond; square hexagonal and their measurement **3 hr**.

Properties of netting material: physical properties- Density, twist and amount of twist, Breaking strength-tenacity, & tensile strength, breaking length, abrasion resistance, elasticity, extensibility, water absorption &, shrinkage, sinking velacity, weather resistance, melting point and visibility. Chemical and Biological properties **2 hr**.

Floats – buoys – its materials, types their properties; Classification of floats: based on shape and materials; calculation of buoyancy. Sinkers – types, materials, properties- negative buoyancy. Factors to be considered while designing /selection of fishing gears; Biological, Environmental, oceanographical, Vessel characteristics and mesh size regulation **2 hr**.

Choice of netting materials for trawl, gillnet and purse seine. Classification of trawl gears. 2 seem trawl; 4 seam trawl and wing trawl. Design and construction of wing trawl. Rigging of trawl gear: Arrangements of bridles, sweep lines and attachment of ground gears: tickler chain, bobbins and rock hoppers and attachment of otter board **3 hr**

Practicals

Study of net making tools; Knots and hitches used in net making. Methods of net making: Hand braiding- Chain mesh method and loop methods of net making. Shaping of webbing: baiting, creasing and reducing mesh size step by step **2 hr**.

Tailoring method : T and N direction of webbing; T-cuts, N-cuts, B-cuts and their combination.Joining of net pieces. Net mounting –hanging coefficient, hung depth and their calculation.Selvedging. Methods of net mounting: reeving, stapling and norselling. Mending and net shooter techniques **3 hr**.

Properties of netting material: physical properties- Density, twist and amount of twist, Breaking strength-tenacity, & tensile strength, breaking length, abrasion resistance, elasticity, extensibility, water absorption &, shrinkage, sinking velacity, weather resistance, melting point and visibility. Chemical and Biological properties **2 hr**.

Floats – buoys – its materials, types their properties; Classification of floats: based on shape and materials; calculation of buoyancy. Sinkers – types, materials, properties- negative buoyancy. Factors to be considered while designing /selection of fishing gears; Biological, Environmental, oceanographical, Vessel characteristics and mesh size regulation **2 hr**.

Choice of netting materials for trawl, gillnet and purse seine. Classification of trawl gears. 2 seem trawl; 4 seam trawl and wing trawl. Design and construction of wing trawl. Rigging of trawl gear: Arrangements of bridles, sweep lines and attachment of ground gears: tickler chain, bobbins and rock hoppers and attachment of otter board **3 hr**

Suggested readings:

1) FAO 1975 :Modern Fishing Gears of the world. Fishing News (Books) Ltd. England 607p

2) Hameed,M and Boopenderanath M.R. 2001 : Modern Fishing Gear Technology.Daya Publishing House, Delhi 186p

3) Garner,J.1977 : How to make and set nets. Fishing News (Books) Ltd. England 95p

4) Gerhard,K.1973. : Netting Materials for fishing gears. Fishing News (Books) Ltd. England 175p

5) Liber.L and Mancomps.A.1978 : Mending of Fishing Gear. Fishing News (Books) Ltd. England 112p

6)Meenakumari, B., Boopendranath, M.R., Pravin, P., Thomas, S.N. and Edwin, L. (2009) (Eds) : *Handbook of Fishing Technology*, Central Institute of FisheriesTechnology, Cochin: viii+372 p.: Niseema Printers & Publishers, Cochin-682 018

7)Sreekrishna, Y. and Shenoy Latha. 2001 :Fishing gear and craft technology. Indian Council of Agricultural Research, New Delhi, 342p.

FET 311 Fishing Craft Technology 2(1+1)

Theory

Introduction: History & development of fishing crafts. Traditional fishing crafts of India -**1 hr**. Classification of fishing crafts based on fabrication dimension, nature of fishing, depth of operation- **1 hr**. History & development of mechanization of fishing crafts **-1hr**. Basic geometric concepts and important terminologies of fishing vessel -**2 hrs**. Form coefficients, properties of irregular shapes Calculation of longitudinal and transverse sectional area of fishing craft by using Trapezoidal rule and Simpson's rules- 3 **hrs**. State of equilibrium; Volume of displacement; centre of gravity (CG); centre of buoyancy (CB); vertical centre of gravity (VCB); longitudinal centre of gravity (LCB). Stability of fishing vessels- longitudinal and transverse. Various equilibrium of ships-stable, unstable and neutral; Light weight, Dead weight, Tonnage system; Gross Registered Tonnage (GRT), Net Registered Tonnage (NRT) -**3 hrs**. Boat building materials: Choice of construction materials: Wood, properties, advantages and disadvantages- **3 hrs**. Deck fitting. Maintenance oif fishing vessels.fouling and boring organisms; seasoning and preservation of wood- **2 hrs**. Constructional details of boat: Offset tables; Mould lofting; Backbone assembly of wooden boat. Constructional details of Steel, FRP, Ferro Cement and Aluminum boats. Introduction of Outboard and inboard engines -**2 hrs**.

Suggested Readings

Fyson JF. (Ed). 1985. *Design of Small Fishing Vessels*. Fishing News Books.

Marine Institute. 1988. Proc. World Symposium on Fishing Gear and Fishing Vessel Design, The Newfoundland and Labrador Institute of Fisheries and Marine Technology, St. John's, Newfoundland, Canada.

Pike D. 1992. *Fishing Boats and Their Equipments*. Fishing News Books.

Ponnambalam A. 2003. *Fishing Craft Technology*. CIFNET, Cochin.

Sanisbury JC. 1996. *Commercial Fishing Methods-An Introduction to*

Vessels and Gear. Fishing News Books.
Shenoy L. 1988. *Course Manual in Fishing Technology*. CIFE, Mumbai.
Sreekrishna Y & Shenoy L. 2001. *Fishing Gear and Craft Technology*.
ICAR.
Traung T. 1967. *Fishing Boats of the World*. Fishing News Books.
227
Yadav YS. 2002. *Traditional Fishing Craft of the Bay of Bengal*. BOBP,
Chennai.

FET312. Aquaculture Engineering 3 (2+1)

Theory

Fish Farm- Definition, objectives, types of farms; fresh water, brackish water and marine farms.**1 hr**

Selection of site for aqua farm- site selection criteria, pre-investment survey viz., accessibility, physical features of the ground, detailed survey viz., site condition, topography, soil characteristic **2 hr**.

Land Surveying- definition, principles of surveying, classification of surveying, instruments used for chaining, chaining on uneven or sloping ground and error due the incorrect chain length. **1 hr**

Chain surveying- definitions, instruments used for setting out right angles, basic problems in chaining, cross staff survey. **1 hr**

Compass surveying - definitions, bearing, meridians, whole circle bearing system, reduced bearing system, theory of magnetic compass, prismatic compass. **1 hr**

Leveling - definitions, methods of leveling, leveling instruments, terms and abbreviations, types of spirit leveling. **1 hr**

Plane table surveying- instruments required, working operation, methods. **1 hr**

Contour surveying- definition, contour interval, characteristics of contour, contouring methods and uses of contour **1 hr**.

Calculation of area of regular and irregular plane surfaces, Trapezoidal and Simpson's rule, volume of regular and irregular shape as applied to stacks and heaps, **3hr**

calculation of volume of pond. Earth work calculations- excavation, embankment, longitudinal slope and cross slope, calculation of volume of earth work as applied to roads and channels **3 hr**.

Soil and its properties- classification of soil; soil sampling methods; three phase system of soil, definitions of soil properties andpermeability of soil.**2hr**

Ponds - classification of ponds; excavated ponds, embankment ponds, barrage and diversion ponds; rosary system and parallel system. **1 hr**

Planning of fish ponds, layout planning, materials planning, manual planning, comparison of square and rectangular ponds, large and small ponds; **1 hr**

Types of ponds; nursing ponds, rearing ponds and stocking ponds.**1 hr**

Design of ponds, pond geometry; shape, size, bottom slope of pond *etc.*, construction ponds viz., marking, excavation etc., **1 hr**

Dykes, types of dykes viz., peripheral dykes, secondary dyke, design of dykes, construction of dykes **1 hr**.

Water distribution system- canal, types of canals; feeder canal, diversion canal etc., **1 hr**

Pipe line system, Water control structures- types of inlet and out let and their construction. **1 hr**

Water budget equation, Pond drainage system; seepage and the methods used for seepage control, evaporation; factors affecting evaporation, erosion of soil in dykes and its control.**2hr**

Site selection, planning and construction of coastal aqua farms. Brackish water fish farms- tide fed, pump fed farms, site selection - topography, tidal amplitude, soil and water sources etc. **2hr**, Hatcheries- site selection, infrastructural facilities; water supply system, main hatchery complex viz., Layout plan and design of hatcheries- brood stock ponds, artemia hatching tanks, sheds etc,**2hr**

Raceway culture system- site selection, layout plan, types of raceway culture system viz.,parallel system, series system etc.,**1 hr**

Aerators- principles, classification of aerators and placement aerators. **1 hr**

Pumps- purpose of pumping, types, selection of pump, total head, horse power calculation.**2hr**

Filters- types and constructions **2 hr**.

Practicals

Evaluation of potential site for aquaculture. Land survey – chain surveying, compass surveying, leveling, plane table surveying and contouring; soil analysis for farm construction. Design and layout plan of fresh water and brackish water farms and hatcheries. Design of farm structure: ponds, dykes and channels. Earth work calculations and water requirement calculation. Visit to different types of farms.

Suggested readings

1) Bose et al 1991 : *Coastal Aquacultural Engineering*, Oxford and IBH Publication Co Pvt Ltd, New Delhi

2) Kanetkar, T.P. & Kulkarni, S.V. 1980 :*Surveying and Leveling Vol I*,VidyarthiGrihaPrakasan, Pune

3) Lawson, Thomas, B 1995 : Fundamentals of Aquacultural Engineering. Chapman & Hall, New York

4) Odd-Ivar Lekang2007 : *Aquaculture Engineering*,Blackwell Publishing Ltd, 9600 Garsington Road, Oxford OX4 2DQ, UK

5) Wheton, Federick.W 1985 : Aquacultural Engineering. John Wiley & Sons, New York

FET 321. Fishing Technology2 (1+1)

Theory

Structure of various commercial fishing gears.**1 hr**Rigging of fishing gears: Bridles, sweep lines, otter boards, floats and ground gears arrangements. **1 hr**

Otter door: Different types of otter doors. Behavior of otter doors in water: Angle of attack, angle of heel and angle of tilt.**1hr** Fishing accessories – thimbles, shackles, C-links, rings, G-links, Kelly's eye, stopper, bottle screw, **1 hr**

Deck layout of different fishing vessels.**1hr** Trawling: Beam trawling; otter trawling; side trawling; twin trawling out rig trawling bull trawling and mid water trawling. **1 hr**

Constructional details of single boat purse seine; two boat purse seine and method of operation.**2 hr**

Types of gill net – constructional details of simple gill net, trammel gill net, stick held gillnet, frame gillnet and vertical line gillnet, Operation of gillnet: set gillnetting; drift gillnetting; bottom , mid water and pelagic gillnetting.**2 hr**

Line fishing: Types of hooks; structure and size of hooks. Constructional details of long line, tuna long line, vertical long line, pole & line and trolling line. Operation of long line: set and drift long lining: bottom, mid water and pelagic long lining; jigging. **2 hr**

Operation of beach seine, boat seine and traps.**1 hr**

Selectivity in fishing gear and by catch reducing devices.**1 hr**

Deck equipments – types of winches, net haulers, line haulers, triple drum, gurdy, power blocks, fish pumps.**2 hr**

Fishing equipment: Fish finder, GPS navigator, sonar, net sonde, gear monitoring equipment.**2 hr**

Practicals

Survey of fishing gears; Trawl; gillnet; long line and purse seine fishing gears. Rigging of trawl, purse seine, gillnet and hook & line.

Commercial fishing techniques: Bottom trawling; purse seining; gillnetting and line fishing. Cast net fishing and trap fishing

Suggested readings

Brandt.A.V. 1984. : Fish catching methods of the world. Fishing News Book Ltd. England. 240p

FAO 1972 : Modern Fishing Gears of the world. Fishing News Book Ltd. England. 607p

FAO 1981 : Modern Fishing Gears of the world. Fishing News Book Ltd. England. 605p

Fridman, A.L.1986 : Calculations for fishing gear designs, Fishing News Book Ltd. England. 264p

Hameed,M and Boopenderanath M.R. 2001 : Modern Fishing Gear Technology.Daya Publishing House, Delhi 186p

Meenakumari, B., Boopendranath, M.R., Pravin, P., Thomas, S.N. and Edwin, L. (2009) (Eds) : *Handbook of Fishing Technology*, Central Institute of FisheriesTechnology, Cochin: viii+372 p.: Niseema Printers & Publishers, Cochin-682 018

Sreekrishna, Y. and Shenoy Latha. 2001 :Fishing gear and craft technology. Indian Council of Agricultural Research, New Delhi, 342p.

DEPARTMENT OF MANAGEMENT STUDIES

MGT 112 Information and Communication Technology 2 (1+1)

Theory

IT and its importance. IT tools, IT-enabled services and their impact on society; computer fundamentals; hardware and software; input and output devices; word and character representation **-3 hrs**.features of machine language, assembly language, high-level language and their advantages and disadvantages-**2hr**s.principles of programming- algorithms and flowcharts-**2h**rs. Operating systems (OS) - definition, basic concepts, introduction to WINDOWS and LINUX Operating Systems-**2hr**s.Local area network (LAN), Wide area network(WAN), Internet and World Wide Web, HTML and IP-**1hr**.Introduction to MS Office - Word, Excel, Power Point-**2 hrs.** Audio visual aids - definition, advantages, classification and choice of A.V aids-**2hr**s.cone of experience and criteria for selection and evaluation of A.V aids-**2 hr**s.video conferencing. Communication process, Berlo' s model, feedback and barriers to communication-**2 hrs.**

Practicals

Exercises on binary number system, algorithm and flow chart; MS Word; MS Excel; MS Power Point; Internet applications: Web Browsing, Creation and operation of Email account; Analysis of fisheries data using MS Excel. Handling of audio visual equipments. Planning, preparation, presentation of posters, charts, overhead transparencies and slides. Organization of an audio visual programme.

Selected Readings:

ITL Education Solutions Ltd.	Introduction to Computer Science(Second edition)
Rajaraman V &Adabala N	Fundamentals of Computers Prentice Hall India Pvt. Ltd
Anita Goel	Comuter Fundamentals, Pearson Education India; First edition (2010)
A. Adivi Reddy	Extension Educatio ,Sreekalshmy Press, Bapatala, Guntur, Andhra Pradesh (1993)

MGT 111 Communication Skills and Personality Development 1 (0+1)

Practicals

Structural and functional grammar; meaning and process of communication, verbal and non-verbal communication; listening and note taking, writing skills, oral presentation skills; field diary and lab record; indexing, footnote and bibliographic procedures. Reading and comprehension of general and technical articles, précis writing, summarizing, abstracting; individual and group presentations, impromptu presentation, public speaking; Group discussion. Organizing seminars and conferences.

Selected Readings:

1.	Sheppard. C A	A sense of English S H Book Depot, Changanassery, 1957
2.	John Furberg and Richard Hopkins	Colleg Style sheet 49th Avenue Press. British Columbia, Canada, Bendall Books (4thedn)1996
3.	Reddy C R	Research Methodology in Social Sciences-Daya Publishing House, New Delhi
4.	Sasikumar V., KiranmaiDutt and GeethaRajeevan	Communication Skills in English. Cambridge University Press India Pvt. Ltd. New Delhi. 2016.

Compulsory Non-Credit Courses (CNC)

MGT 113 Physical Education, First Aid & Yoga Practices 1 (0+1)

Practicals

Introductiontophysicaleducation: definition, objectives, scope, history, development and physicalculture; Meaning and importance of Physical Fitness and Wellness; Physical fitness components -speed, strength, endurance, power, flexibility, agility, coordination and balance; Warming up - General & Specific & its Physiological basis; Test and measurement in physical education; Training and Coaching - Meaning & Concept; Methods of Training; aerobic and anaerobic exercises; Calisthenics, weight training, circuit training, interval training, Fartlek training; Effects of Exercise on Muscular, Respiratory, Circulatory & Digestive systems; Balanced Diet and Nutrition: Effects of Diet on Performance; Physiological changes due to ageing and role of regular exercise on ageing process; Personality, its dimensions and types; Role of sports in personality development; Motivation and Achievements in Sports; Learning and Theories of learning; Adolescent Problems & its Management; Posture; Postural Deformities; Exercises for good posture.

Yoga; Introduction to - Asanas, Pranayam, Meditation and Yogic Kriyas; Role of yoga in sports; Governance of sport in India; Important national sporting events; Awards in Sports; History, latest rules, measurements of playfield, specifications of equipments, skill, technique, style and coaching of major games(Cricket, football, table Tennis, Badminton, Volleyball, Basketball, Kabaddi and Kho-Kho) and Athletics

Need and requirement of first-aid.First-Aid equipments and upkeep. Handling and transport of injured Itraumatized persons. Emergency procedure for suffocation, demonstration of artificial respiration.Treatment of injuries(wound sand bleeding)-methods of dressing and bandages; first-aid procedure for injured bones. Handling unconsciousness; Treatment of bum sand scalds. Emergency procedure for poisoning with special references to snake bite.Injuries and accidents in fishing, fish processing factories, chemical laboratories and their treatments. Shock

injuries to muscles and joints and treatments.Sports injuries and their treatments.

MGT 121 Statistical Methods 3 (2+1)

Theory

Definition of statistics**,** Concepts of population, sample, Census and sample surveys, Classification of data, frequency and cumulative frequency table,**-4 hrs.** Diagrammatic and graphical representation of data - bar diagrams, pie-diagram, histogram, frequency polygon, frequency curve and Ogives-**4 hrs**. Important measures of central tendency - arithmetic mean median and mode. Relative merits and demerits of these measures **-2 hrs**. Important measures of dispersion, Range, Mean Deviation, Variance and Standard Deviation. Relative merits and demerits of these measures **,** Coefficient of variation-**3hrs**.
Normal Curve, Concepts of Skewness and kurtosis 1 **hr**. Definitions of probability, mutually exclusive and independent events, conditional probability, addition and multiplication theorems. -**3hrs.**Random variable, concepts of theoretical distribution; Binomial, Poisson and Normal distributions and their use in fisheries,-5 **hr**s. Basic concept of sampling distribution; standard error and central limit theorem-**2 hrs**. Introduction to statistical inference, general principles of testing of hypothesis, types of errors-**3hrs.** Tests of significance based on Normal, t, and Chi-square distributions-**3hrs.**Bivariate data, scatter diagram, simple linear correlation, measure and properties, linear regression, equation and fitting; relation between correlation and regression, Length weight rel
ationship in fishes; applications of linear regression in fisheries -3**hrs**.Sampling Techniques, Basic sampling designs, Simple random sampling, Stratified random sampling, systematic sampling, clustersampling Methodology for estimation of marine fish landings in India, Estimation of inland fish production in India and problems encountered -3 **hrs**.

Practicals

Construction of questionnaires and schedules.Diagrams and frequency graphs.Calculation of arithmetic mean, median, mode, range, mean deviation, variance, standard deviation. Exercises on probability, Binomial and Poisson distributions, Area of normal curve ,confidence interval for population mean, Test of hypothesis based on normal, t, and chi-square. Computation of Simple correlation and regression.Fitting of length - weight relationship in fishes.

Selected Readings :

Biradar,R.S. (2002). Course Manual on Fisheries Statistics, Central Institute of Fisheries Education (ICAR),Mumbai.
Bliss,C.I. (1970). Statistics in Biology, McGraw-Hill Book Company, New York.
Gomez,K.A. and Gomez,A.A. (1984).Statistical Procedures for Agricultural Research, John Wiley and Sons, New York.
Jerrold H Zar (2003) Biostatistical Analysis, Pearson Education Pvt. Ltd.

Mandal R C and Nambiar P T N (2002). Agricultural Statistics: Techniques and Procedures. Agrabios(India), Jodhpur.
Rangaswamy,R. (2010). A Textbook of Agricultural Statistics, New Age International Publishers, New Delhi.

MGT 122 Swimming 1 (0+1)

Practicals

History,hazards in water and safety precautions; pool maintenance and water quality control. Learning swimming, understanding and practice of ducking the head, kicking action, holding breath under water and various strokes (free style, breast stroke, butterfly, back stroke); competitive swimming-relays and medleys, lap time practice, swimming and floating aids andtheiruses;diving-stylesofdiving,rules,regulationsandprecautions.Methodsoflife saving in water; Boating, canoeing and sailing: types, maintenance, skill development, rules and regulations and practice.

MGT 211 Fisheries Co-operatives and Marketing 2 (1+1)

Theory

Principles and objectives of co-operation, co-operative movement in fisheries in India, structure, functions, status and problems of fisheries co-operatives management in relation to resources, production and marketing -**2 hrs**. Role of credit for fisheries development, credit requirements of fishers, source and type of credit/finance, micro-credit, indigenous and institutional finance, structure of institutional finance in fisheries; returns, risk bearing ability and recovery in fisheries sector-**2 hrs**.role of NABARD in fisheries development; role of insurance in fish and shrimp farming and industry-**2 hrs**. Basic accounting procedures, profit and loss account - **2 hrs.**

Introduction to marketing management; core marketing concepts: market structure, functions and types, marketing channels and supply chain, marketing margins, marketing environment, marketing strategies, product development and product mix, consumer behavior and marketing research- **2 hrs**. Fish markets and marketing in India, demand and supply of fish, market structure and price formation in marine and inland fish markets; cold storage and other marketing infrastructure in India-**2 hr**s.export markets and marketing of fish and fishery products; Trade liberalization and fisheries markets. Integrated marketing approach in fisheries-**2 hrs**. Sea food export case study on product and market diversification- export and import policies (fisheries)-**2 hrs**.New product development and market segmentation. Export and import policies relevant to fisheries sector-**2 hrs**.

Practicals

Developing questionnaire and conducting market surveys, analysis of primary and secondary market data. Exercises on equilibrium price for fish and fishery products; estimation of demand and supply using simple regression. Analysis of credit schemes of banks and the government. Case studies of cooperatives. Visit to co-operative societies, commercial banks and fish markets and organizations dealing with marketing of fish and fishery products. Pattern and Performance of India's Seafood Exports; Case studies on product and market diversification. Case studies on competitiveness of Indian fish and fish products.

Selected Readings

Pandey, I.M. Financial Management. Vikas Publishers, New Delhi. 2002.

S. Maheswari. Financial Management. S. Chand & Co. New Delhi. 2006.

Philip Kotler. Marketing Management.Printice Hall, London. 2001.

Francis Cherunilam. International Business (3rd Ed.).Printice Hall. 2004.

Krishnaswami, O.R. Theory, History and Practice of Co-operation, S. Chand & Co. New Delhi. 1197.

Malhotra and Sinha.Indian Fisheries and Aquaculture in a Globalizing Economy. Narendra, New Delhi. 2006.

IIM, Ahmedabad. Marine Fish Marketing in India.Concept Publishing House, New Delhi. 1984.

IIM, Ahmedabad. Inland Fish Marketing in India.Concept Publishing House, New Delhi. 1984.

MGT 221 Fisheries Extension Education 2 (1+1)

Theory

Introduction to extension education and fisheries extension - concepts, objectives and principles; extension education, formal and informal education; History and role of fisheries extension in fisheries development-**2 hrs**. Fisheries extension methods- individual, group and mass contact methods and their effectiveness, factors influencing their selection and use -**2 hr**s.characteristics of technology, transfer of technology process; important TOT programs in fisheries; role of NGOs and SHGs in fisheries-**3 hr**s. Fisheries co-management; Adoption and diffusion of innovations, adoption and diffusion process, adopter categories and barriers in diffusion of fisheries innovations-**2hr**s. Extension program planning and evaluation - steps and importance; participatory planning process, PRA and PTD-**3 hrs**. Basic concepts in rural sociology and psychology and their relevance in fisheries extension**2 hr**s.social change, social control, social problems and conflicts in fisheries-**2 hr**s.gender issues in fisheries; theories of learning, learning experience, learning situation- **2 hrs.**

Practicals

Familiarization of extension teaching techniques-Collection of socio-economic data from fishing villages; study of social issues/problems through participatory and rapid rural appraisal techniques, stake holders analysis and needs assessment; assessment of development needs of community and role of formal and non – governmental organizations through stakeholder analysis; case studies on social/gender issues and social conflicts in fisheries. Case studies on extension programs and Success stories. Practical exercises on conducting fish farmers meet.

Selected Readings

1.A.AdiviReddy.Extension Education, Sree Lakshmi Press, Bapatala, Guntur, AP1993

2.O.P.Dahama &O.P.Bhatnagar.Education and Communucation for Development (2nd Edition), Oxford and IBH publishing Co.Pvt.Ltd.,New Delhi.1987

3.G L Ray Extension communication and Management (3rd Edition),Naya Prokash,206 BidanSarani, Calcutta.1991.
4.J.B.Chitambar, Introductory Rural sociology, Wiley Eastern Limited, New Delhi, 1985
5.Neela Mukherjee, Participatory Rural Appraisal, Methodology and Applications,Concept Publishing company, New Delhi.1998.

MGT 311 Fisheries Economics 3 (2+1)

Theory

Introduction to fisheries economics, basic economic terminologies – micro and macroeconomics, positive and normative economics, environmental economics-3**hrs**. Micro-economics: resource, scarcity, utility analysis, theories of consumption, demand, supply; Consumer surplus-**5 hrs**. Elasticity – price, income, cross, application of elasticity in fisheries managerial decision-**2 hrs**. Market – equilibrium price-**3 hrs**. Costs and returns –breakeven analysis of fish production system; concepts of externalities and social cost; factors of production, marginal cost and return, Significance or importance of marginal cos-**4 hrs**. Farm production economics – production functions in capture and culture fisheries. Farm-firm relationships, law of diminishing marginal return, returns toscale, economies of scale and scope, revenue, profit maximization, measurement oftechnological change, farm planning and budgeting-**3 hrs**. Macro-economics: Introduction to national income, accounting, measurement and determinants of national income, contribution of fisheries to GNP and employment; contribution of fisheries sector to the economic development of the country. Balance of payments, economic growth and sustainable development-**3 hrs**. Globalization: dimensions and driving Force- **2 hrs**. Introduction to GATT and WTO. WTO Framework – Key Subjects - Agreement on Sanitary and Phytosanitary Measures (SPS), Seafood Export Regulations- **2 hr**s.Non-Tariff Barriers (NTBs) and Agreement on Anti-Dumping Procedures-**2 hrs**.Fisheries Subsidies and WTO-**1 hr**. Fisheries Trade and Environment; protests against globalisation and WTO-**2 hrs**.Intellectual Property Rights (IPR) and different forms.Patents and patenting process, Agreement on TRIPS, Bio-piracy, GMOs in fisheries**2 hrs**. Salient features of Indian Patent (Amendment) Act 2005. Overview of Patents in Indian fisheries sector-**2 hrs**.

Practicals

Demand and supply functions of fish market – determination of equilibrium price for fish and fisheries products, calculation of price, income and cross elasticities. Production function – production with one or two variable inputs.Shifting demand and surplus curve and its importance in fish price. Economic analysis on cost, return and breakeven of any two production units like fish farm / shrimp farm / seed production unit /fish processing plant / export unit.

Selected readings:

Alfred W. Stonier & Hague. A text book of economic theory (5thed.). The English Language Book Society, Longman Group Ltd, London. 1980.
Dewett. K.K. Modern Economic Theory (25thed.) S. Chand and Co. Pvt. Ltd. New Delhi. 1987.

Varshney R.L. & K.L. Maheswary. Managerial Economics (9thed.). Sultan Chand & Co. New Delhi. 1985.
John Goodwin & Evan Drummond H. Agricultural Economics (2nded.) Reston Publishing Co. Inc., APrintice-Hall Co., Reston, U.S.A. 1996.
Gulland J.A. Management of Marine Fisheries.Scienttechnica (Publishers) Ltd., Bristol. 1974.
Lee G. Anderson. The Economics of Fisheries Management. John Hopkins University Press, Baltimore. 1977.
I.I.M. Fish Marketing in India.Indian Institute of Management, Ahmadabad. 1983.
Yung C. Shang. Aquaculture Economics.Basic Concepts and Method of Analysis.The World Aquaculture Society, Honolulu, Hawaii. 1990.
R. Korakandy. Economics of Fisheries Management.Daya Publishing House, Delhi. 1996.
Syam S. Salim, R.S. Biradar and S.K. Pandey. Fisheries Economics and Marketing – An Introduction. CIFE, Mumbai. 2005.
P.S.Rao. Fishery Economics and Management in India.Pioneer Publishers and Distributors, Bombay. 1983.
G.S. Gupta. Managerial Economics. Tata McGrahill Publishing Co., New Delhi. 1990
Albert M.Koers. International Regulation of Marine Fisheries. A Study of Regional Fisheries Organizations .Fishing News (Books) Ltd. Surry England. 1973.
R. Sathiadhas. Production and Marketing Management of Marine Fisheries in India.Daya Publishing House, New Delhi. 1987.
Lawson R.M. Economics of Fisheries Development. Frances Printer (Publisher), London. 1984.

Publications of: FAO; MPEDA; CMFRI, Dept. of Fisheries; Planning Board; Govt. of India Ministry of Agriculture & Animal Husbandry

MGT 312 Fisheries Policy and Law 1 (1+0)

Theory

Introduction to public administration, principles of organization and management of publicenterprise (**1hr**.) Central and State responsibilities for fisheries development, organizational set up of fisheries administration at the Centre and state levels (**2 hrs**.) Present relevance of past fisheries policies and recent policies in fisheries sector (**1 hr**.) Functions and powers of functionaries of department of fisheries, corporations and cooperatives (**1 hr**.). Different central and state level fisheries institutions.Role of Central and State Government in the regulatory activities of Aquaculture and fisheries (**2hrs**.) Implementation of community based resource management plans. Historical review of fisheries development and management in India (**1 hr**.).International agencies / organizations for promotion of fisheries worldwide. Fisheries legislation: Overview of fisheries and aquaculture legislations in India (**2 hrs**.). Indian Fisheries Act, 1897- **2 hrs**. International environmental legislation and its impact on fisheries-**1 hr**. Laws relating to conservation and management of fishery resources in marine and inland sectors-**1 hr**. Objectives, functions and authority of fishery regulatory agencies like Coastal Regulatory Zone (CRZ) and Aquaculture Authority of India-**2 hrs**. Brackishwater aquaculture act, Marine fisheries policy, Laws relating to fish products and marketing. International Law of the Seas and international commissions on fisheries and their impact -**2 hrs**.

Selected readings:

Indian Fisheries Act, 1897
Kerala Marine Fisheries Regulation Act, 1980
Govt. of India, Ministry of Environment & Forests, Department of Environment, Forests and Wildlife,CRZ Act, 1991.
http://www.caa.gov.in

MGT 321 Fisheries Business Management and Entrepreneurship Development 1 (1+0)

Theory

Concept of entrepreneurship; entrepreneurial and managerial characteristics; managing an enterprise; motivation and entrepreneurship development- **2 hr**s. importance of planning, monitoring, evaluation and follow up; managing competition; entrepreneurship development programs**2hr**; Generation, incubation and commercialization of ideas and innovations-**1 hr**. Government schemes and incentives for promotion of entrepreneurship- **2 hrs**. Preparation of enterprise budget for integrated fish farming- **1hr**. Fiscal and monitory policies and its impact on entrepreneurship-**1hr**. Infrastructural and other financial requirement for fishery entrepreneurship Government policy on Small and Medium Enterprises (SMEs) / SSIs.Venture capital. Contract farming and joint ventures, public-private partnerships- **2 hrs**. Characteristics of Indian fisheries processing and export industry-**2 hrs**. Introduction to fish business management-Concept of management, management process (planning, organising, staffing, leading and controlling)-**1 hr**. Organizational behaviour, human resource planning, new dimensions in fish business environment and policies-**1 hr.** Emerging trends in fish production, processing, marketing and exports-**1 hr**. Assessing overall business environment in the Indian economy. Overview of Indian social, political and economic systems and their decision making by individual entrepreneurs-**1hr**. Globalisation and the emerging business /entrepreneurial environment. Social Responsibility of Business -**1 hr**.

Selected Readings:

1. Campleman, G: Manual on the Identification and Preparation of Fishery Investment Projects, Fisheries Technical paper , 149. FAO, Rome, 1976.
2. Maheswari, S.N: Financial Management – Sultan Chand & Sons, New Delhi, 2005.
3. Pandy, I.M: Financial Management. Vikas Publishing Home Pvt. Ltd. 1997.
4. David H. Holt:Entrepreneurship: New Venture Creation, 2001.
6. A.K.Rai: Entrepreneurship Development, Vikas Publishing Home Pvt. Ltd. 1997.

***