MAHATHMA GANDHI UNIVERSITY

PRIYADARSHINI HILLS
KOTTAYAM-682 560

RESTRUCTURED CURRICULUM FOR POST GRADUATE
PROGRAMME UNDER CREDIT AND SEMESTER SYSTEM

POST GRADUATE PROGRAMME

IN

APPLIED FISHERIES & AQUACULTURE

(EFFECTIVE FROM 2012 ADMISSION ONWARDS)

MHATMAGANDHIUNIVERSITY PG PROGRAMME
REGULATIONS FOR CREDIT AND SEMESTER SYSTEM
(MGU-CSS-PG)
Salient features

I. These Regulations shall come into force from the Academic Year 2012-2013 onwards.

II. The regulation provided herein shall apply to all regular post-graduate programmes, MA/MSc/MCom, conducted by the affiliated colleges/Institutions (Government/Aided/unaided/ Self-financing, and Constituent colleges of Mahatma Gandhi University with effect from the academic year 2012-2013 admission onwards.

III. The provisions here in supersede all the existing regulations for the regular post-graduate programmes conducted by the affiliated colleges and centres of the Mahatma Gandhi University unless otherwise specified.

IV. These shall not apply for the programme conducted in distance/ off campus and private registration mode which will continue to be in annual scheme.

V. Every Programme conducted under Credit Semester System shall be monitored by the College Council.

2. Programme structure

(a) Project work shall be completed by working outside the regular teaching hours. Project work shall be carried out under the supervision of a teacher in the concerned department. A candidate may, however, in certain cases be permitted to work on the project in an industrial / Research Organization on the recommendation of the supervisor.

(b) There should be an internal assessment and external assessment for the project work. The external evaluation of the Project work is followed by presentation of work including dissertation and Viva-Voce. The title and the credit with grade awarded for the program project should be entered in the grade card issued by the university.

(c) Assignments: Every student shall submit one assignment as an internal component for every course with a weightage one. The Topic for the assignment shall be allotted within the 6th week of instruction.

(d) Seminar Lectures - Every student shall deliver one seminar lecture as an internal component for every course with a weightage two. The seminar lecture is expected to train the student in self-study, collection of relevant matter from the books and Internet resources, editing, document writing, typing and presentation.

(e) Every student shall undergo at least two class tests as an internal component for every course with a weightage one each. The weighted average shall be taken for awarding the grade for class tests.

(f) The attendance of students for each course shall be another component of internal assessment as prescribed with weightage one.

(g) No course shall have more than 4 credits.

(h) Comprehensive Viva-voce shall be conducted at the end semester of the program comprehensive Viva-Voce covers questions from all courses in the programme.

3. Attendance

(a) The minimum requirement of aggregate attendance during a semester for appearing the end semester examination shall be 75%. Condonation of shortage of attendance to a maximum of 10 days in a semester subject to a maximum of two times during the whole period of post graduate programme may be granted by the University.

(b) If a student represents his/her institution, University, State or Nation in Sports, NCC, NSS or Cultural or any other officially sponsored activities such as college union / university union activities, he/she shall be eligible to

claim the attendance for the actual number of days participated subject to a maximum of 10 days in a Semester based on the specific recommendations of the Head of the Department and Principal of the College concerned.

(c) A student who does not satisfy the requirements of attendance shall not be permitted to take the end Semester examinations.

4. Registration/duration

(a) The duration of PG programmes shall be 4 semesters. The duration of each semester shall be 90 working days. Odd semesters from June to October and even semesters from December to April. There will be one month semester breaks each in November and May.

(b) A student may be permitted to complete the programme, on valid reasons, with in a period of 8 continuous semesters from the date of commencement of the first semester of the programmes.

5. Admission

(a) The admission to all PG programmes shall be as per the rules and regulations of the University. The eligibility criteria for admission shall be as announced by the University from time to time. Separate rank lists shall be drawn up for reserved seats as per the existing rules. The college shall make available to all students admitted a Prospectus listing all the courses offered including programme elective during a particular semester. The information provided shall contain title of the course and credits of the course.

(b) There shall be a uniform academic and examination calendar prepared by the University for the conducing the programmes. The University shall ensure that the calendar is strictly followed.

(c) There shall be provision for inter collegiate and inter University transfer in 3rd semesters within a period of two weeks from the date of commencement of the semester.

(d) There shall be provision for credit transfer subject to the conditions specified by the Board of Studies concerned.

6. Admission requirements

(a) Candidates for admission to the first semester of the PG programme through CSS shall be required to have passed an appropriate Degree Examination in any branch of life Sciences of Mahatma Gandhi University as specified or any other examination of any recognized University or authority accepted by the Academic council of Mahatma Gandhi University as equivalent thereto. Admission will be under the Cenralised Admission Process (CAP) of Mahathma Gandhi University.

(b) The candidate must forward the enrollment form to the Controller of Examinations of the University through the Head of the Institution, in which he / she is currently studying.

(c) The candidate has to register all the courses prescribed for the particular semester. Cancellation of registration is applicable only when the request is made within two weeks from the time of admission.

(d) Students admitted under this programme are governed by the Regulations in force.

7. Promotion
A student who registers for the end semester examination shall be promoted to the next semester

8. Examinations

(a) There shall be University examination at the end of each semester.

(b) Practical examinations shall be conducted by the University at the end of each semester.

(c) Project evaluation and Viva -Voce shall be conducted at the end of the programme only. Practical examination, Project evaluation and Viva-Voce shall be conducted by two external examiners and one internal examiner.

(d) End-Semester Examinations: The examinations shall normally at the end of each semester.

(e) There shall be one end-semester examination of 3 hours duration in each lecture based course and practical course.

(f) A question paper may contain short answer type/annotation, short essay type questions/problems and long essay type questions. Different types of questions shall have different weightage to quantify their range. Weightage can vary from course to course depending on their comparative importance, but a general pattern may be followed by the Board of Studies.

9. Evaluation and grading

(a) Evaluation: The evaluation scheme for each course shall contain two parts; (a) internal evaluation and (b) external evaluation. 25% weightage shall be given to internal evaluation and the remaining 75% to external evaluation and the ratio and weightage between internal and external is 1:3. Both internal and external evaluation shall be carried out using direct grading system.

(b) Internal evaluation: The internal evaluation shall be based on predetermined transparent system involving periodic written tests, assignments, seminars and attendance in respect of theory courses and based on written tests, lab skill/records/viva and attendance in respect of practical courses. The weightage assigned to various components for internal evaluation is a follows.

Table 1 Components of Internal Evaluation:

Component	Weightage
(i) Assignment	1
(ii) Seminar	2
(iii) Attendance	1
(iv) Two Test papers	2

Table 2 Grade points:

Letter Grade	Performance	Grade point (G)	Grade Range
A	Excellent	4	3.5 to 4.00
B	Very Good	3	2.5 to 3.49
C	Good	2	1.5 to 2.49
D	Average	1	0.5 to 1.49
E	Poor	0	0.0 to 0.49

Table 3 Grades for Attendance:

% of attendance	Grade
>90%	A
Between 85 and 90	B
Between 80 and below 85	C
Between 75 and below 80	D
< 75	E

Table 4 Assignment: grading components:

Component	Weight
Punctuality	1
Review	1
Content	2
Conclusion	1
Reference	1

Table 5 Seminar: grading components:

Component	Weight
Area/ topic selected	1
Review/reference	1
Content	2
Presentation	2
Conclusion	1

Table 6 Practical: Internal assessment components:

Component	Weight
Attendance	1
Laboratory involvement	2
Written/ lab test	2
Record	2
Viva voce/Quiz	1

Table 7 Project evaluation: Internal:

Component	Weight
Punctuality	1
Experimentation/ data collection	1
Compilation	1
Content	1

Table 8 Project evaluation: External:

Component	Weight
Area/ topic selected	1
Objectives	2
Review	1
Materials and methods	2
Analysis	2
Presentation	2
Conclusion/ Application	2

(c) To ensure transparency of the evaluation process, the internal assessment grade awarded to the students in each course in a semester shall be published on the notice board at least one week before the commencement of external examination. There shall not be any chance for improvement for internal grade.

(d) The course teacher and the faculty advisor shall maintain the academic record of each student registered for the course which shall be forwarded to the University through the college Principal and a copy should be kept in the college for at least two years for verification.

(e) External evaluation: The external Examination in theory courses is to be conducted by the University with question papers set by external experts. The evaluation of the answer scripts shall be done by examiners based on a well-defined scheme of valuation. The external evaluation shall be done immediately after the examination preferably through Centralized Valuation

(f) Photocopies of the answer scripts of the external examination shall be made available to the students for scrutiny on request and revaluation/scrutiny of answer scripts shall be done as per the existing rules prevailing in the University.

(g) The question paper should be strictly on the basis of model question paper set by BOS and there shall be a combined meeting of the question paper setters for scrutiny and finilisation of question paper. Each set of question should be accompanied by its scheme of valuation.

10. Direct grading system

Direct Grading System based on a 5 - point scale is used to evaluate the performance (External and Internal Examination of students).

Table 9 Direct grading system: Grade points

Letter Grade	Performance	Grade point (G)	Grade Range
A	Excellent	4	3.5 to 4.00
B	Very Good	3	2.5 to 3.49
C	Good	2	1.5 to 2.49
D	Average	1	0.5 to 1.49
E	Poor	0	0.0 to 0.49

(a) The overall grade for a programme for certification shall be based on CGPA with a 7- point scale given below:
Table 10

CGPA	Grade
3.80 to 4.00	A+
3.50 to 3.79	A
3.00 to 3.49	B+
2.50 to 2.99	B
2.00 to 2.49	C+
1.50 to 1.99	C
1.00 to 1.49	D

(b) A separate minimum of C Grade for internal and external are required for a pass for a course. For a pass in a programme a separate minimum grade C is required for all the courses and must score a minimum CGPA of 1.50 or an overall grade of C and above.

(c) Each course is evaluated by assigning a letter grade (A, B, C, D or E) to that course by the method of direct grading. The internal (weightage =1) and external weightage =3) components of a course are separately graded and then combined to get the grade of the course after taking into account of their weightage.

(d) A separate minimum of C grade is required for a pass for both internal evaluation and external evaluation for every course.

(e) A student who fails to secure a minimum grade for a pass in a course will be permitted to write the examination along with the next batch. There will be no supplementary examination.

(f) After the successful completion of a semester, Semester Grade Point Average (SGPA) of a student in that semester is calculated using the formula given below. For the successful completion of semester, a student should pass all courses and score a minimum SGPA of 1.50. However, a student is permitted to move to the next semester irrespective of her/his SGPA. For instance, if a student has registered for 'n' courses of credits C1, C2 …………, Cn in a semester and if she/he has scored credit points P1, P2…………., Pn respectively in these courses, then SGPA of the student in that semester is calculated using the formula;

SGPA = (P1 + P2 +…………….+Pn)/(C1 + C2 +……………+ Cn)

CGPA = [(SGPA)1*S1 + (SGPA)2*S2 + (SGPA)3*S3 + (SGPA)4*S4]/ (S1+ S2 + S3 + S4)
Where S1, S2, S3, and S4 are the total credits in semester 1, semester 2, semester 3 and semester 4.

11. Pattern of questions

(a) Questions shall be set to assess knowledge acquired, standard application of knowledge, application of knowledge in new situations, critical evaluation of knowledge and the ability to synthesize knowledge. The question setter shall ensure that questions covering all skills are set. He / she shall also submit a detailed scheme of evaluation along with the question paper. A question paper shall be a judicious mix of short answer type, short essay type/ problem solving type and long essay type questions.

(b) Weight: Different types of questions shall be given different weights to quantify their range as fallows.
Table 11.

Sl. No.	Type of questions	Weight	No. of questions to be answered
1.	Short answer type questions	1	5 out of 8
2.	Short essay(problem solving type questions)	2	5 out of 8
3.	Long essay type questions	5	3 out of 6

12. Grade card

The University under its seal shall issue to the students, a grade card on completion of each semester, which shall contain the following information.

a) Name of the University.
b) Name of college
c) Title of the PG Programme.
d) Name of Semester
e) Name and Register Number of students
f) Code number, Title and Credits of each course opted in the semester, Title and Credits of the Project Work
g) Internal, external and Total grade, Grade Point (G), Letter grade and Credit point (P) in each course opted in the semester.
h) The total credits, total credit points and SGPA in the semester.

The Final Grade Card issued at the end of the final semester shall contain the details of all courses taken during the entire programme including those taken over and above the prescribed minimum credits for obtaining the

degree. The Final Grade Card shall show the CGPA and the overall letter grade of a student for the entire programme.

13. Award of degree
The successful completion of all the courses with 'C+' grade shall be the minimum requirement for the award of the degree

14. Monitoring committee
There shall be a Monitoring Committee constituted by the Vice-chancellor to monitor the internal evaluations conducted by institutions. The Course teacher, Faculty Advisor, and the College Coordinator should keep all the records of the internal evaluation, for at least a period of two years, for verification.

15. Grievence redressal committee
(a) College level: The College shall form a Grievance Redress Committee in each Department comprising of course teacher and one senior teacher as members and the Head of the Department as Chairman. The Committee shall address all grievances relating to the internal assessment grades of the students. There shall be a college level Grievance Redress Committee comprising of Faculty advisor, two senior teachers and two staff council members (one shall be an elected member) and the Principal as Chairman.
(b) University level: The University shall form a Grievance Redress Committee as per the existing norms.

Table 12. Programme course, teaching hours and credit distribution - Total credits - 80

Semester	Course	Teaching Hrs.	Credit	Total credits
I	PC-1	4	4	19
	PC-2	4	4	
	PC-3	4	4	
	PC-4	3	3	
	Practical	10	4	
II	PC-5	4	4	19
	PC-6	4	4	
	PC-7	4	4	
	PC-8	3	3	
	Practical	10	4	
III	PC-9	4	4	19
	PC-10	4	4	
	PC-11	4	4	
	PC-12	3	3	
	Practical	10	4	
IV	PE-1	5	4	23
	PE-2	5	4	
	PE-3	5	4	
	Practical	10	4	
	Project	-	4	
	Viva-Voce	-	3	

Consolidation of grades for internal evaluation
If B, C, B, and A grades are scored by a student for attendance, assignment, seminar and test paper respectively for a particular course, then her/his CE for that course shall be consolidated as follows:

Table 13

Component	Weight (W)	Grade awarded	Grade point (G)	Weighted Grade Points (W x G)
Attendance	1	B	3	3
Assignment	1	C	2	2
Seminar	2	B	3	3
Test paper	2	A	4	8
Total	6			16
Grade: Total weighted grade points/Total weights = 16/6 = 2.66 = Grade B				

B. Consolidation of grades for external (one answer paper - Theory)

The grade of an answer paper (ESE Practical) shall be consolidated by similar procedure discussed above by assigning weights for the various components. (E.g., Procedure, Experiment, Calculation, Accuracy of the reported values, Presentation of results, Diagrams, etc). The boards of studies shall define the components and their weights and include them in the scheme and syllabus of each practical course.

Table 14.

Type of question	Question Nos.	Grade awarded	Grade points	Weightage	Weighted Grade Points
Short answer	1	B	3	1	3
	2	-	-	-	0
	3	A	4	1	4
	4	D	1	1	1
	5	-	-	-	0
	6	A	4	1	4
	7	B	3	1	3
	8	-	-	-	0
Short essay	9	B	3	2	6
	10	C	2	2	4
	11	-	-	-	0
	12	-	-	-	0
	13	B	3	2	6
	14	A	4	2	8
	15	C	2	2	4
	16	-	-	-	0
Long essay	17	C	2	5	10
	18	-	-	-	0
	19	-	-	-	0
	20	B	3	5	15
	21	D	1	5	5
	22	-	-	-	0
Total				30	73
Calculation : Overall grade of an answer paper = sum of weighted grade points/ sum of the weightage = 73/30 = 2.43 = Grade C					

C. Consolidation of the grade of a course: The grade for a course is consolidated by combining the ESE and CE grades taking care of their weights.

For a particular course, if the grades scored by a student are C and B respectively for the external and the continuous evaluation, as shown in the above examples, then, the grade for the course shall be consolidated as follows:

Table 15.

Exam	Weight	Grade awarded	Grade points (G)	Weighted Grade point (W x G)
External	3	C	3	9
Internal	1	B	3	3
Total	4			12
Grade of a course (GPA)	Total weighted grade points/Total weights = 12/4 = 3.00 = Grade B			

D. Consolidation of SGPA

SGPA is obtained by dividing the sum of credit points (P) obtained in a semester by the sum of credits (C) taken in that semester. After the successful completion of a semester, Semester Grade Point Average (SGPA) of a student in that semester shall be calculated using the formula given. Suppose the student has taken three courses each of 4 credits and 2 courses each of 2 credits in a particular semester. After consolidating the grade for each course as demonstrated above, SGPA has to be consolidated as shown below:

Table 16.

Course code	Title of course	Credit (C)	Grade awarded	Grade points (G)	Credit Points (P = C x G)
01	--	4	A	4	16
02	--	4	C	2	8
03	--	4	B	3	12
04	--	2	C	2	4
05	--	2	B	3	6
Total		16			46
SGPA	Total credit points/ Total credits = 46/16 = 2.87 = Grade B				

E. Consolidation of CGPA

If the candidate is awarded two A grades, one B Grade and one C Grade for the four semesters and has 80 credits, the CGPA is calculated as fallows.

Table 17.

Semester	Credit taken	Grade	Grade point	Credit points
I	19	A	4	76
II	19	A	4	76
III	19	B	3	57
IV	23	C	2	46
Total	80			255
CGPA	Total credit points/ Total credits = 255/80 = 3.18 (which is between 3.00 and 3.49 in 7 point scale). The overall grade awarded is B+			

Abstract of the CSS Programme in Applied Fisheries and Aquaculture

	Code	Course	Hours/ Week	Total Hours	Credit
SEMESTER- I	AFA1T01	Taxonomy and systematics of Cultivable Aquatic Organisms	5	90	4
	AFA1T02	Biochemistry	5	90	4
	AFA1T03	Biophysics and research Methodology	5	90	4
	AFA1T04	Biostatistics and Computer application	5	90	4
	AFA1P05	Taxonomy, Biochemistry, Biophysics, Biostatistics and Computer applications	5	90	3
		TOTAL	**25**	**450**	**19**
SEMESTER- II	AFA2T06	Inland Aquaculture	5	90	4
	AFA2T07	Ornamental Fisheries	5	90	4
	AFA2T08	Genetics and Biotechnology in Aquaculture	5	90	4
	AFA2T09	Health Management in Aquaculture	5	90	4
	AFA2P10	Inland Aquaculture, Ornamental Fisheries and Fish Health management	5	90	3
		TOTAL	**25**	**450**	**19**
SEMESTER- III	AFA3T11	Mariculture	5	90	4
	AFA3T12	Fish Nutrition	5	90	4
	AFA3T13	Microbiology and Quality control	5	90	4
	AFA3P14	Aquaculture and Fish Nutrition	5	90	3
	AFA3P15	Microbiology and Quality control	5	90	3
	AFA3P16	Hatchery Training*		-	1
		TOTAL	**25**	**450**	**19**
SEMESTER- IV	AFA4T17	Fisheries business Management	5	90	4
	AFA4T18	Fish capture Technology & Management	5	90	4
	AFA4T19	Fish Processing technology	5	90	4
	AFA4P20	Fish Capture Technology	5	90	2
	AFA4P21	Fish Processing Technology	5	90	2
	AFA4Pt22	Project**	-	-	4
	AFA4Vv23	Viva voce***	-	-	2
	AFA4Tr24	Training ****	-	-	1
		TOTAL	**25**	**450**	**23**
		Grand total			**80**

*Training on freshwater fish/Ornamental fish/shrimp hatchery extending a period not less than a week may be attended and a certified report may be submitted.

** Project may be undertaken either under the faculty of the Department or under an external faculty approved by the Department or in combined guidance. Review works may be avoided. A paper published by the candidate as the first author in an accredited journal can be considered as equivalent to dissertation.

***A comprehensive viva covering the entire topics covered.

****A training for not less than TWO WEEKS must be attended in a reputed government institution and a certified report along with attendance certificate may be produced

AFA1T01   Taxonomy and Systematics of
Cultivable Aquatic Organisms

AFA1T02   Biochemistry

AFA1T03   Biophysics and research
Methodology

AFA1T04   Biostatistics and Computer
application

AFA1P05   Taxonomy, Biochemistry, Biophysics,
Biostatistics and Computer
applications

AFA1T01- TAXONOMY AND SYSTEMATICS OF CULTURABLE AQUATIC ORGANISMS (90HRS)

BIOSYSTEMATICS

Module I. Biological Classification   **5hrs.**

Hierarchy of categories and higher taxa. Taxonomic Procedures-collection, preservation. Taxonomic characters of different kinds- quantitative and qualitative analysis of variation, Process of typification, different zoological types and their significance.

Module II. Methods of Biosystematics   **5hrs.**

Classical and modern methods-Typological, Phenetics, Evolutionary, Phylogentic, Cladistics and Molecular Taxonomy. Phylocode, Tree of Life and Bar-coding of Life.

Module III. Taxonomic Publications   **5hrs.**

Keys, types, use of keys, merits and demerits. International Code of Zoological Nomenclature(ICZN), Rules and formation of Scientific names of different taxa. Homonymy and Synonymy.

Module IV. Concepts and Techniques in Systematics   **5hrs.**
Concept of species- taxonomic diversity within species. Molecular Phylogeny-use of Proteins, DNA and RNA. Phylogenetic trees.

TAXONOMY OF CULTIVABLE AQUATIC ORGANISMS

Module V Introduction   **10hrs**

Position of fishes in the phylum chordate, Various trends in the classification of fishes.

Module VI Classification   **10hrs**

Major approaches to classification as discussed by Nelson (1994). General characters, evolution and classification of Fishes

Module VII Taxonomic features   **10hrs**

Study of external morphology of typical placoderm, elasmobranchs and teleosts.
TAXONOMY OF CRUSTACEA   **10hrs**

Module VIII-Classification
Classification of major crustaceans upto orders.
Module IX Taxonomic features   **10hrs**

External characters of *P. monodon, Scylla serrata* and *Panilurus homarus*

TAXONOMY OF MOLLUSCA

Module X Classification   **5hrs**

Classification of phylum mollusca upto orders.

Module XI Taxonomic feartures   **10hrs**

External characters of Mussle, Oyster, clam, gastropods and cephalopods.

TAXONOMY OF ECHINODERMATA

Module XI Classification   **5hrs**

Classification of Phylum Echinodermata upto classes.

RFERENCE

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AFA1T02 BIOCHEMISTRY   90 Hours

Unit I. Introduction   2 hrs.

Atoms, molecules and chemical bonds. Water: biological importance, pH and acid - base balance. Buffers - biological importance.

Unit II. Carbohydrates   10 hrs.

Monosaccharides: Classification and nomenclature, Biological importance, Structural representations of sugars-Acetal and hemiacetal, ketal and hemiketal linkages, Glucose, fructose, galactose, mannose and ribose. Isomerism – structural isomerism and stereoisomerism, optical isomerism, epimerism and anomerism. Mutarotation and inversion of sugars. Reactions of monosaccharides: Oxidation, reduction, ester formation, osazone formation. Glycosidic bond. Disaccharides: Sucrose, Lactose, Maltose, Isomaltose, Cellobiose and Trehalose.
Polysaccharides: Homopolysaccharides- Starch, Glycogen, Cellulose, Chitin, Dextrans, Inulin, Pectin. Heteropolysaccharides- Hyaluronic acid, Heparin, Chondroitin sulphate, Keratan sulphate, Dermatansulphate and Agar-agar. Glycoproteins and Mucoproteins.

Module III. Proteins   10 hrs.

Structure, classification and properties of amino acids. Amphoteric properties of amino acids, pK value and iso-electric point of amino acids. Peptide bond formation and peptides. Reactions (due to carboxyl group, amino group and side chains). Colour reactions of amino acids and proteins.
Primary structure of protein (*e.g.* insulin). Classification and properties of proteins. Conformation of proteins- chemical bonds involved, Secondary structure- Alpha helix, Collagen helix, Beta pleated sheet, Ramachandran angles and Ramachandran map.
Fibrous proteins- examples (Keratin, Collagen, Elastin, Resilin, Fibrous muscle proteins). Chaperons. Tertiary structure- *e.g.* Myoglobin. Quaternary structure – *e.g.* Haemoglobin.

Module IV. Lipids   10 hrs.

Classification of lipids: simple, compound and derived lipids. Biological importance of lipids.
Fatty acids: classification, nomenclature.
Simple fats: Triacylglycerol (Triglycerides) - Physical properties. Reactions-Hydrolysis, Saponification, Rancidity. Acid number, Saponification number, Iodine number, Polenske number and Reichert-Meissl number of lipids. Waxes.
Compound lipids: Phospholipids- Lecithin, Phosphatidyl inositol, Cephalins, Plasmologens. Glycolipids, Sphingolipids. Derived Lipids, Steroids: Biologically important steroids-cholesterol, Vitamin D, Bile acids, Ergosterol, Terpenes, Lipoproteins.
Prostaglandins- structure, types, synthesis and functions.

Module V. Nucleic Acids   10 hrs.

Structure of nucleic acids and nucleotides: Structural organization of DNA (Watson –Crick model) Characteristic features of A, B, C and Z DNA. Structural organization of tRNA; Protein-nucleic acid interaction. DNA regulatory proteins, folding motifs, conformation flexibilities, denaturation, renaturation, DNA polymerases, Restriction endonucleases. Biological roles of nucleotides and nucleic acids.

Module VI. Enzymes   **10 hrs.**

Classification- (I.U.B.system), co-enzymes, iso-enzymes, ribozyme. Enzyme specificity. Mode of action of enzymes. Formation of enzyme substrate complex. Lowering of activation energy, Various theories, Active site.

Enzyme kinetics: Michaelis-Menten equation. Km value and its significance. Enzyme velocity and factors influencing enzyme velocity. Kinetics of enzyme inhibition, suicide inhibition and feedback inhibition.

Enzyme regulation: Allosteric regulations- Key enzymes, Covalent modification. Enzyme engineering .

Module VII. Carbohydrate Metabolism   **12 hrs.**

Major metabolic pathways- Glycolysis – Fate of pyruvate. Citric acid cycle and its significance; Central role of citric acid cycle. Oxidative and substrate level phosphorylation. Gluconeogenesis, Cori cycle.

Glycogen metabolism - Glycogenesis, Glycogenolysis, Adenylate cascade system, Ca^{+2} Calmodulin-sensitive phosphorylase kinase. Regulation of glycogen synthesis .

Minor metabolic pathways of carbohydrates: Pentose Phosphate pathway, Glucuronic acid metabolism.Galactose metabolism. Inborn errors associated with carbohydrate metabolism. Glycogen storage diseases,Lactose intolerance, Galactosuria.

Module VIII. Metabolism of Proteins   **10 hrs.**

Amino acid metabolism-Deamination, Transamination and Trans-deamination. Formation and disposal of ammonia. Urea cycle. Fate of carbon skeletons of aminoacids: glucogenic, ketogenic, partly glucogenic and ketogenic with examples. Synthesis of biologically significant compounds from different aminoacids with special reference to glycine, glutamic acid, phenylalanine, tyrosine and tryptophan.

Module IX. Metabolism of Lipids   **8 hrs.**

Beta oxidation, alpha oxidation and omega oxidation of fatty acids.   *De novo* synthesis of fatty acids. Metabolism of cholesterol, synthesis and its regulation. Biosynthesis of triglycerides. Metabolism of ketone bodies - Ketogenesis, Ketolysis, Ketosis.

Module X. Nucleic Acid and Mineral Metabolism   **8hrs.**

Catabolism of purines and pyrimidines.
Major and minor nutrients. Role of Calcium, Phosphorus, Magnesium, Sodium, Potassium, Chloride, Sulphur and Iron.

Free radicals and antioxidants, Generation of free radicals. Reactive oxygen species. Free radical scavenger systems. Lipid peroxidation. Preventive antioxidants.

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AFA1T03 BIOPHYSICS AND RESEARCH METHODOLOGY   90 HOURS

BIOPHYSICS   30HOURS
Unit 1 Diffusion and Osmosis   10 Hours

    1.1 Diffusion
        1.1.1   Kinetics of diffusion
        1.1.2   Concentration gradient and Fick's law
        1.1.3   Diffusion coefficient
        1.1.4   Stokes-Einstein equation
        1.1.5   Electrical gradient
        1.1.6   Pressure gradient and Graham's law
        1.1.7   Gibbs-Donnan equilibrium
        1.1.8   Facilitated diffusion
    1.2 Osmosis
        1.2.1   Vant Hoff Laws
        1.2.2   Osmotic concentration and Osmotic pressure
        1.2.3   Biological significance of osmosis in fishes

Unit 3 Bioenergetics   10 Hours

    3.1 Thermodynamics
    3.1.1 Laws of thermodynamics, Entropy, Enthalpy, Free energy, Reversible

        thermodynamics, irreversible thermodynamics, isolated, closed and open systems.

    3.2 Photo Bioenergetics

    3.2.1 Photosynthesis, photosynthetic reaction – light reaction and dark

    reaction – Redox potential.

    3.3 Chemo-bioenergetics (oxidative phosphorylation); Electron transport system
        redox couples – redox potential – chemiosmotic theory – ATP sysnthesis.

Unit 4 Radiation Biophysics   10Hours
    4.1 Ionizing radiations, interaction of radiation with matter. Detection and

    measurement of radiation (Dosimetry).

    4.2 Application of radioactive tracers. Biological effects of radiation. Radiation

protection and therapy.

4.3 GM counter, liquid scintillation counter.

RESEARCH METHODOLOGY   **60 Hours**

Unit 5   Types of Microscopic Preparations   **8 Hours**

5.1 Fixation, preparation of temporary and permanent slides, whole mounts,

smears, squashes and sections. Specimen preparations for TEM and SEM, shadow casting, freeze fracturing, freeze etching, negative staining.

Unit 6   Cytochemical Methods   **5 Hours**

6.1 Cytochemistry of nucleic acids, detection of carbohydrates, lipids and proteins.

Unit 7   Museum Preparations   **4 Hours**

7.1 Preservation of animals, alizarin preparation, stuffing skeletal preparations.

Unit 8   Microscopy: Principle, instrumentation and application   **12 Hours**

8.1 Light microscope, camera lucida, micrometry

8.2 Dark field microscope

8.3 Phase contrast microscope

8.4 Fluorescence microscope

8.5 Electron microscope (TEM and SEM)

8.6 Photomicrography

8.7Autoradiography

Unit 9 Chromatography: General principles and techniques   8 **Hours**

9.1 Column chromatography

9.2 Paper chromatography

9.3 Thin layer chromatography

9.4 Gas chromatography and GLC

9.5 Ion exchange chromatography

9.6 Gel filtration

9.7 HPLC

9.8 Affinity chromatography

Unit 10 Electrophoresis   5 **Hours**

10.1 Paper electrophoresis

10.2 Gel electrophoresis

10.3 Polyacrylamide gel electrophoresis **(SDS)**

10.4 High voltage electrophoresis

10.5 Immuno-electrophoresis

Unit 11 Spectroscopy, AAS   **2 Hours**

Unit 12 NMR, RIA, ELIZA   **4 Hours**

Unit 13 Flame photometry   **1 Hour**

Unit 14 Colorimetry and spectrophotometry   **2 Hours**

Unit 15 Centrifugation   **2 Hours**

15.1 Types of centrifuges
15.2 Differential and density gradient centrifugation

Unit 16 pH Meter   **1 Hour**

Unit 17 Research   **6 Hours**

17.1 Scientific research

17.2 Research: Basic and applied

17.3 Preparation of research papers and thesis

17.4 Preparation of project proposals

17.5 Research and extension

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1. Baker, E.J. and Silverton, R.E.(1978). Introduction of medical laboratory technology. ELBS.
2. Das, D. (1991). Biophysics and Biophysical Chemistry. Academic Publishers, Calcutta.
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4. Foyer, C.H., (1984). Photosysthesis. Wiley, New York.
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12. Weesner, F.M. (1960), General Zoological Microtechniques. The William and Wilkins Company. Baltimore.

AFA1T04   BIOSTATICS AND COMPUTER APPLICATION   90 HOURS

Biostatistics

Module 1.Basics of Biostatistics   **6 hrs.**

Steps in Statistical Investigation, Data and Variable (Collection , Types , Sources).

Population, Sample, Sampling Methods (Random, Cluster, Stratified and Geographical) and Sampling Errors/Bias.

Organization of Data - Editing, Classification, Tabulation (forming a frequency distribution from raw data, types and characteristics of a Frequency Table).

Presentation of Data - types and characteristics of Tables and Visual aids – Graphs, Charts, Diagrams, Flow charts, Cartographs.

Statistical Analysis Tools-Parametric and Non-Parametric; Bivariate and Multivariate Analysis.

Interpretation and Forecasting.

Module II.   Measures of Central Tendency   **4 hrs.**

Introduction, Characteristics, Merits and Demerits of Mean, Median and Mode.

Calculations/Problems for different data (raw, frequency table).

Harmonic and Geometric Mean (Brief account only).

Module III. Measures of Dispersion   **5 hrs.**

Introduction, Characteristics, Merits and Demerits of Range, Quartile Deviation,

Mean Deviation and Standard Deviation. Calculations/Problems for frequency table.

Standard Error and Relative Measures of Dispersion, Skewness and Kurtosis- (Brief account only).

Module IV. Correlation Analysis   **3 hrs.**

Correlation -types and methods of correlation analysis,Problems for Karl Pearson's correlation coefficient and Spearman's rank correlation.

Module V. Regression Analysis   **7 hrs.**

Regression and Line of Best Fit, Types and methods of regression analysis.

Graphic Methods (Scatter method, Curve fitting). Algebraic method (Fitting of strait line through regression equation).

Probit Analysis (Brief account only), Mathematical Models in Biology (Brief account only).

Length - Weight Relationship.Von- Bertalanffy's Growth (VBG) Model.

Module VI. Theory of Probability   **4 hrs.**

Measures of Probability and Theorems in Probability. Probability distributions –
Binomial, Poisson and Normal (Brief Account only).

ModuleVII. Testing of Hypothesis   7 hrs.

Hypothesis and types, Confidence Interval, Sampling, Methods and Errors. Tests of significance (For large and small samples – Critical Ratio and P value). Z Test (Problem for small samples), Chi- Square Test (Problem for 2×2 table only). Student's 't' test (Problem for small samples comparing mean of two variable). F-test and Analysis of Variance (ANOVA - One way) (Brief account only).Non-parametric tests: Mc Nemar and Mann Whitney U test (Brief account only).

Module VIII. Computerised Information systems & Fisheries   4 hrs.
Remote sensing applications, Global Positioning systems, GIS and Fisheries, Statistical data analysis packages.

Computer Applications (30 hrs.)

Module I. Basics of Computers   6 hrs.
Types of Computers. Binary Number System, Digital and Analog systems.

Hardware/Software/Firmware. Basics of Computer Functioning- Booting; Formatting; File, File Extensions; Temporary Files; Folder; GUI, Icon; Installation of Programs, Commands, Bios-setup, Date and Time, Memory Partitions, Registry, Default Operations; Defragmentation (Brief account only).

Module II. Hardware Basics   7 hrs.
Memory -Classification and Types of memory; memory devices; Units.

Input Devices -Types, working and functions. Output Devices –Types, working and functions.
CPU components - Processors, Mother boards, SMPS, Accessory Cards – Graphic /Sound/
Networking/Bluetooth/Wifi (Brief account only).
New Generation Computers - Servers, Laptop; Palmtop; Cyborgs; Robotics, Zoobotics (Brief account only).
Module III. Software Basics   10 hrs.

System Software/Operating System -System Files; Working of OS; DOS, Widows, Linux and UNIX (Brief account only).

Application Software -Programs and Packages, Calculator, MS Paint, MS Word, MS Excel, MS PowerPoint, Publisher, Acrobat Reader, E Book Reader, Explorer, Photoshop.
 Virus and Antivirus (Brief account only).

Statistical Software (MS Excel, PH Stat, SPSS).

Databases -MS Access (Brief account only).

Module IV. Computer Language and Programming   **7 hrs.**

Computer language -Classification and types, HTML, C and Java

Programming concepts -Algorithm, Codes (Brief account only).

Module V. Networking, Internet and Information Technology   **10hrs.**

Computer Communication -Network Topology, Media of networking, Networking

Protocols, PAN, LAN, WAN, MAN, INFLIBNET, Modem and Gateway.

Internet and Internet Services -World Wide Web, Uploading, Downloading, Hosting, Portal, Search Engines, Firewall.

Global Information System -BIOSIS, Medline and Medlars, AGRIS; E Journals and E Books Publishing.

Cyber Crime and Cyber Laws (Brief account only).

Computerised information systems in Fisheries   **10hrs**

Remote sensing applications, GPS, Statistical data analysis packages, Aquaculture soft wares.

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Pradeep Sinha and Priti Sinha.2010.Compu*ter Fundamentals.* BPB Publications., New Delhi

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Shane Torbert.2011. *Applied Computer Science* . Springer-verlag, New York.

Sudipto Das.2010. *AComplete Guide to Computer Fundamentals.* Lakshmi Publishers (P) Ltd. New Delhi

Sundar Rao,P.S.S and J.Richard.2006.*Introduction to Biostatistics and Research Methods* (4th edn). Prentice Hall, New Delhi.

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Zar, Jerrold H. 2008 (3rd edn.). *Biostatistical Analysis.* Pearson Education Inc., Delhi.

AFA1P05 -TAXONOMY, BIOCHEMISTRY, BIOPHYSICS

PRACTICAL

Taxonomy, Biochemistry, Biophysics, Biostatistics and Computer Applications

1.   Identification of commercially important species of fishes, crustaceans and mollusks.

     i) 25 species from 12 families of fishes   ii) Crustacea and Mollusca – 5 each

2.   Identification of fishes up to species level using dichotomous key

3.   Identification of eggs, larvae and post larvae of commercially important species of fishes, crustaceans and mollusks.

4.   Identification of fish bones and study of skeletal system in fishes, a minimum of one cartilaginous fish and one bony fish.

5.   Analysis of physico-chemical parameters of seawater, freshwater and brackish water.

6.   Estimation of glucose, protein, total lipid, cholesterol in serum/tissue

7.   Estimation of acid phosphatase, alkaline phosphatase in blood, serum/tissue

8.   Chromatography (paper/TLC) for the separation and identification of amino acids

9.   Polyacrylamide gel electrophoresis/paper electrophoresis for the separation of proteins

10.   Micrometry

11.   Phase contrast microscope, camera lucida, micro-photographic equipment

12.   Preparation of permanent whole mounts

13.   Preparation of double stained serial sections to study histological details (intestine/liver/gill).

14.   Bio-statistics - problems (Mean, Median, Standard deviation, Correlation, Graphs and Diagrams)

15.   Computer application: Analysis of data, graphical representation and interpretation. Experience for students to solve simple statistical problems like Chi-square, t-test and to represent data in tables and graphics.

Semester II

AFA2T06   Inland aquaculture

AFA2T07
Ornamental   Fisheries   Genetics   and

AFA2T08   Biotechnology in Aquaculture

AFA2T09   Health Management in Aquaculture systems

Practical
AFA2P10   **Inland aquaculture, Ornamental Fisheries, Fish Health Management**

AFA2T06-INLAND AQUACULTURE   90 HOURS
Unit 1 Selection of Sites for Aquaculture   5 **Hours**

   1.1 Land-based farms
   1.2 Open-water farms.

Unit 2 Selection of species for Culture   **5 Hours**

   2.1 Biological characteristics of aquaculture species

   2.2 Economic and market considerations

   2.3 Exotic species

   2.4 Common aquaculture species of commercial importance

Unit 3 Culture systems development and Management   **30 Hours**

   3.1 Freshwater and brackish water aquaculture systems

   3.2 Present status and potential for freshwater and brackish water aquaculture in India

   3.3 Natural collection of seed- Carp, Mullet, Milk fish, Pearl spot,Tiger prawn

   3.4 Pond preparation – Drying, liming and water intake

   3.6 Natural food production by fertilization – organic and inorganic fertilizers

   3.7 Principles of stocking: composition and proportion

   3.8 Supplementary feeding

   3.9 Sampling for growth estimation and stock assessment

   3.10 Monitoring food availability – assessing phytoplankton production,

   Zooplankton qualitative and quantitative estimation

   3.11 Monitoring health of stock

   3.12 Disease management

   3.13 Water quality management

3.14 Rate and time of water exchange

3.15 Harvest time and methods of harvest

3.16 Assessment of production rate

3.17 Acclimatization and transportation of live fish and fish seed

3.18 Organic aquaculture

3.19 Responsible Fisheries and aquaculture

Unit 4 Control of weeds, pests and predators   5 **Hours**

4.1 Common aquatic weeds

4.2 Methods of weed control and its impact on the ecosystem.

4.3 Control of predators, weed animals and pests

Unit 5 Other Culture methods/systems   **25 Hours**

5.1 Monoculture

5.2 Polyculture

5.3 Integrated farming

5.4 Cage culture

5.5 Pen culture

5.6 Raft culture

5.7 Extensive culture

5.8 Semi-intensive culture

5.9 Intensive culture

5.10 Race way culture

5.11 Culture in recirculatory systems

5.12 Warm water and cold water aquaculture

5.13 Sewage fed fish culture

5.14 Recent advances

Unit 6   Fin fish culture   **10 Hours**

6.1 Operational details of monoculture and polyculture of –Milk fish, Mullet, Sea bass, Rabbit fish.

6.2 Sea ranching of finfish

Unit 7   Crustacean culture   5 **Hours**

7.1 Major species used
7.2 Problems in crustacean culture

Unit 8   Molluscan culture   **8 Hours**

8.1 Important freshwater mussels for the production of pearls

8.2 Edible Molluscan species and heir culture

REFERENCES

1. Beveridge, M.C.M. (1987) Cage aquaculture. Fishing News
2. Davy E.B. and M.Graham Eds (1982) Bivalve culture in Asia and Pacific. IDRC Asia Regional Office Syngapore.
3. Milne.P.H (1972) Fish and shell fish farming in China. Fishing News
4. Bardach, J.E.W (1972) Aquaculture farming and husbandry of freshwater and marine organisms
5. Galtsoff, P.S., Culture methods for invertebrate animals
6. Thomas P.C (Ed) Current and emerging trends in aquaculture
7. Coche, A.G., Muir, J.F. Simple methods for aquaculture: Pond construction for freshwater
8. Introduction to aquaculture Pillai, T.V.R., Aquaculture principles and practices
9. Jonathan Shepherd, C. (Ed) Intensive Fish Farming
10. William Royce, F., An introduction to the practice of fishery science.
11. Planning of Aquaculture Development. FAO, Fishing News Books
12. Advances in Aquaculture. FAO, Fishing News Books.
13. Pullin, R.S.V. and Chehadeh, Z.H. (Eds.). Integrated Agriculture-Aquaculture Farming Systems. ICLARM.
14 Aquaculture Systems and Practices – A Selected Review. UNDP, FAO

15. Sea Farming and Sea Ranching in China. FAO Fisheries Technical Paper 418

16. Fishery Science – 2002- L.A. Fuiman and R.G. Werner. Blackwell Science

17. Dynamics of pond aquaculture – 1999- H.S. Egna and C.E. Boyd- CRC Press

18. Water quality sampling and analysis. 2000. - Abbasi, S.A.

19. Stock assessment of inland fisheries – 2002- Cowx, I.G

20. Feed management in intensive aquaculture – 2000- Goddard, S

21. Aquaculture, Fish and shellfish farming – 2002- Southgate, P.C

AFA2T07 ORNAMENTAL FISHERIES   **90 HOURS**

UNIT 1 CONSTRUCTION AND MAINTENANCE OF AQUARIUM   **45 Hours**

1.1 Construction of home/public aquarium   **20 Hours**
    1.1.1   Materials used - wooden and metal frames, frameless tanks.
    1.1.2   Sealants and gums.
    1.1.3   Aerators and filters.
    1.1.4   Handnets and other equipments.
    1.1.5   Water quality requirements.
    1.1.6   Temperature control.
    1.1.7   Design and construction of public freshwater and marine aquaria.

1.2 Setting up of aquarium   **5 Hours**
    1.2.1   Gravel/pebbles and other materials
    1.2.2   Aquarium plants
    1.2.3   Ornamental objects and fishes
    1.2.4   Selection of species.

1.3 Nutritional requirements of aquarium fishes   **10 Hours**
    1.3.1   Different kinds of feeds.
    1.3.2   Culture of food organisms.
    1.3.3   Preparation of dry feeds.
    1.3.4   Feeding methods.

1.4 Aquarium Management   **10 Hours**
    1.4.1   Cleaning the aquarium
    1.4.2   Maintenance of water quality.
    1.4.3   Control of snail and algal growth.
    1.4.4   Common diseases of aquarium fishes; diagnosis and treatment.

UNIT 2 AQUARIUM FISHES AND PLANTS   **45 HOURS**

2.1 Species of ornamental fishes, their taxonomy and biology.   **25 Hours**

    2.1.1 Freshwater species - live bearers and egg layers.

    2.1.2 Maturation

    2.1.3 Secondary sexual characters

    2.1.4 Breeding habits

2.1.5 Spawning

2.1.6 Parental care

2.1.7 Fertilization and development of eggs.

2.1.8 Hatching, larval rearing and their health.

2.1.9 Larval feeds and feeding.

2.1.10 Induced breeding and production of monosex fish.

2.1.11 Use of pigments for colour enhancement.

2.2 Marine ornamental fishes   **10 Hours**

2.2.1 Habitat and collection from nature.

2.2.2 Methods of collection.

2.2.3 Transportation of live fish.

2.2.4 Use of sedatives.

2.2.5 Other ornamental organisms - anemones, lobsters, shrimps, octopus, starfish

etc.

2.3 Fresh water plants   **10 Hours**

2.3.1 Taxonomy and morphology.

2.3.2 Multiplication of aquarium plants. - different methods.

2.3.3 Provision of nutrients and optimum environmental conditions for their

growth.

REFERENCES

1.   Scott, P.W. The complete aquarium.

2.   Bailey Mary, Sandford Gina Caring for your aquarium.

3.   Janze, A.O. Aquarium techniques II Fishes and plants.

4.   Dick Mills, You and Your Aquarium.

5.   Brymer, J.M.P., A Guide to Tropical Fish Keeping.

6.   Hawlins, A.D. (Ed). Aquarium Systems. Academic Press.

7.   Hunnam, P. Ward Lock, Living Aquarium.

8.   Ratjak, K. and Zukal, R., Aquarium Fishes and Plants.

9.   Spotte and John Wiley, S., Seawater Aquariums.

10.   Straughan, R.P.L. and Thomas Yoseloff. Salt water Aquarium in the Home.

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13.   Dick Mills and Gwynne Vevere. Tropical Aquarium Fishes. Published by Salamander Books Limited. London.

14.   Carcacson, R.H. A field guide to the Coral Reef Fishes of the Indian and West Pacific Oceans.

15.   Vincent B. Hargreaves. The Tropical Marine Aquarium. Mc-Graw-Hill Book Company. New York.

16.   Guy N. Smith. Profitable Fish Keeping.

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18.   Ornamental aquarium fishes of India- 1999- K.L.Tekrival and A.A. Rao.- TFH United Kingdom.

19.   Marine Ornamental species (collection, culture and conservation) – J.C.Cato and C.L.Brown. – Blackwell Science

AFA2T08 Genetics and Biotechnology in Aquaculture   90 Hours

Unit 1   8 Hours

Introduction to Fish and Shellfish Genetics – Gynogenesis, Androgenesis, hybridogenesis, polyploidy, euploidy, interspecific hybridization, intraspecific crossbreeding, Monosex strains and their importance, sex reversal – mechanisms and applications; developmental biology in fishes and crustaceans; protrandrous, protogynous species and their importance; genotype environment interactions

Unit 2   10 Hours

Endocrine and molecular control of genetics – enzymology of steroid production in fishes; cell types involved in sex steroid production; receptor mediated action of sex steroids; hormonal control of vitellogenesis; hormonal control of sexual maturation; neuroendocrine control of gonadal development

Unit 3   20 Hours

Genetic Engineering and Biotechnology in aquaculture- genetic improvement, selective breeding, domestication and strain evaluation; concept and techniques in the production of SPF, SPR and hi-health stocks in crustacean aquaculture; transgenics and GMO's in aquaculture- reporter genes, AFP, disease resistance genes, growth hormone gene and their regulation; gene transfer mechanisms, gene cloning.

Unit 4   20 Hours

Marker assisted selection, markers and their role in aquaculture biotechnology, DNA markers-RAPD, AFLP, RFLP, phenotypic markers, protein markers; microsatellite markers in fisheries research; linkage mapping; chromosomal engineering; gamete transfer mechanisms in crustaceans; artificial insemination and in-vitro fertilization in fishes and shellfishes; cryopreservation and its applications; biotechnological applications in pearl culture – genetic improvement, improvements in surgical techniques, biomineralization of nacre, tissue culture techniques

Unit 5   12 Hours

Biotechnology and Aquatic Animal health management – development and application of probiotics, prebiotics, bioremediators, immunostimulants, immunomodulators and vaccines – biofilm vaccines, DNA vaccines, recombinant vaccines; PCR in aquatic animal health management- designing primers

for PCR, Hybridoma techniques; PAB's and MAB's in aquatic animal health management, Diagnsostics and their application in aquaculture health management – immunodiagnostics, nucleic acid based diagnostics

Unit 6   **8 Hours**

Bioinformatics and Bioethics - Introduction to Genomics, Proteomics and Bioinformatics in Aquaculture; Bioethics with regard to biotechnological interventions in aquaculture sector-biodiversity and environment related issues, consumer issues associated with GMO's, economic issues, political issues, research issues, patents in biological research, biopiracy, Intellectual Property Rights (IPR) and their significance in aquaculture and fisheries science, documentation for patenting .

Unit 7   **12 Hours**

Marine bioresources – bioactive compounds from the sea, marine natural products and metabolites- microbes, cyanobacteria and allied seaweeds, micro and macro algae, diatoms, echinoderms, bryozoans, soft corals, sponges

REFERENCES
1. Marine Biotechnology (Vol 1, 2 and 3)- 1999 -Fingerman et al., Science Publishers Inc, USA.
2. Aquaculture and Biotechnology – 1999- Karunasagar et al., - Oxford and IBH, New Delhi
3. Fisheries Biotechnology – 2004 – Lakra et al., - Narendra Publishing House
4. Biotechnology and Genetics in Fisheries and Aquaculture -2003 – A.R. Beaumont and K. Hoare – Blackwell Science.
5. Fish in Research – Academic Press, London
6. Immunodetection methods in aquaculture.2001– Adams, A
7. Progress in reproductive endocrinology- 1999 – K.G. Adiyodi
8. Aquaculture and fisheries biotechnology, a genetic approach – 2003- R.A. Dunham
9. Aquaculture and Biotechnology – 2003- Karunasagar, I
10. Reproductive biotechnology in finfish aquaculture – 2002- Lee, C.S.

AFA2T09 Health Management in Aquaculture systems   90 HOURS

Unit 1   **6 Hours**

Relevance of aquatic animal disease with regard to aquaculture, types of diseases- bacterial, viral, protozoan, fungal, environmental, nutritional and miscellaneous. Water and soil quality management and diseases in aquaculture, Stress and its role in fish and shell fish diseases.

Unit 2.   **8 Hours**

Diseases in fin-fish culture- common diseases of fin-fishes; IHN, IPN, Spring Viraemia of Carps, VHS, Furunculosis, Lymphocystis, Bacterial Kidney Disease, EUS.

Unit 3.   **16 Hours**

Diseases of farmed crustaceans Shrimp Diseases- WSSV, IHHNV, YHV, Taura Syndrome Virus, BMN, BP, MBV, LOPV, LOVV, GAV, RPS, HPV, Blue Shrimp Syndrome, Black Gill disease, Soft Shell syndrome, Black spot disease, Bacterial White Spot disease, Luminescent Bacterial Disease, diseases caused by Vorticella, Epistylis, and Zoothanmium, Microsporidian diseases; Mycosis, Cotton Wool Disease, Saprolegniasis; diseases of unknown etiology. Diseases of freshwater prawn- Mid Crop Mortality syndrome, Exuvia Entrapment disease, White Tail Disease, Bacterial Necrosis, Idiopathic Muscle Necrosis. Gaffaekemia in cultured Lobsters.

Unit 4   **3 Hours**

Introduction to diseases of cultured molluscs; Bonamiosis, Marteiliosis, Mikrocystosis.

Unit 5.   **5 Hours**

 Immune system and response in fin-fishes and crustaceans

Unit 6.   **10 Hours**

Techniques in Aquatic Animal Health – Gross observations, procedures for collection of diseased live and dead samples for analysis, preservation of tissues samples, record keeping in aquatic animal health management.

Unit 7   **15 Hours**

Introduction to common techniques in bacteriology, virology, mycology, parasitology and histopathology with regard to identification of fish and shell fish pathogens of relevance to aquaculture, bioassays, Electron Microscopy.

Unit 8.   **12 Hours**

Immuno and Molecular Diagnostics in Aquatic Animal Health Care – Applications of PCR, RT-PCR, ELISA, Dot Blot Hybridisation, FAT, IFAT, RIA.

Unit 9.   **10 Hours**

Disease Management Tools – Immunostimulants, Probiotics, Bioremediators, Enzymes and nutritional supplements, Vaccines, Advanced drug delivery mechanisms, use of specific pathogen free (SPF) and specific pathogen resistant broodstock (SPR).

Unit 10.   **5 Hours**

Policies and Regulatory issues with regard to use of antibiotics and drugs for treatment of fish and shellfish diseases, Role of HACCP and GMP in shrimp disease management, Quarantine and Health Certification issues.

REFERENCES
1. Lionel E. Mawdesley-Thomas (1972) Diseases of Fish. Zoological Society of London.
2. Ronald J. Roberts (1978) Fish Pathology. Cassell Ltd., London.
3. Wedemeyer, Meyer and Smith (1999) Environmental Stress and Fish Diseases. Narendra Publishing House. New Delhi.
4. Zdenek Lucky, M.V. (1977) Methods for the Diagnosis of Fish Diseases. Amerin Publishing Co. Pvt. Ltd.
5. Snieszko, S.F. and Herbert R. Axelrod (1971) Diseases of Fishes. T.F.H. Publication
6. Edward Kingsford, M.D. (1975) Treatment of Exotic Marine Fish Diseases. The Palmetto Publishing Company.
7. Valerie Inglis, Ronald J. Roberts and Niall R. Bromage (1993) Bacterial Diseases of Fish. Balckwell Scientific Publication, London.
8. Austin, B. and Austin, D.A. (1987) Bacterial Fish Pathogens(Diseases in Farm and Wild). Ellis Horwood Limited.
9. George Iwama and Teruyuki Nakanishi (Eds.) (1996) The Fish Immune System – Organism, Pathogen and Environment. Academic Press Publication.
10. Carl J. Sandermann (1970) Principal Diseases of Marine Fish and Shellfish. Academic Press.
11. Carl J. Sandermann (1990) Principal Diseases of Marine Fish and Shellfish Vol. 2 Second Edition. Academic Press.
12. Woo, P.T.K. and Bruno, D.W. (Eds.) (1999) Fish Diseases and Disorders Vol. 3 – Viral, Bacterial and Fungal Infections. CAB International Publishing.
13. Biology of benthic marine organisms – Oxford and IBH
14. Health management in Asian aquaculture – 2000- FAO
15. Fish and shellfish bacteriology manual – 2003- Whitman
16. Immunodetection methods in aquaculture.2001– Adams, A

PRACTICAL II

AFA2P10-INLAND AQUACULTURE, ORNAMENTAL FISHERIES AND FISH HEALTH MANAGEMENT

1. Identification of major candidate species of fishes, crustaceans and mollusks for aquaculture.
2. Calculation of liming requirements.
3. Identification of weed and predatory fishes and insects.
4. Identification of exotic aquarium fishes
   a. Guppies
   b. Platies
   c. Mollies
   d. Sword tail
   e. Gold fish
   f. Gourami
   g. Angel fish
   h. Tetras
   i. Danio
   j. Oscar
   k. Discus

5. Identification of indigenous aquarium fishes
   a. Puntius fasciatus
   b. Puntius denisoni
   c. Puntius filamentosus
   d. Rasbora daniconius
   e. Anio malabaricus
   f. Ristolepis marginata
   g. Barilius bakeri
   h. Horobagrus nigricollaris
   i. Garra mullya
   j. Etroplus maculatus
   k. Tetradon Travancorensis

6. Identification of marine ornamental fishes
   a. Chaetodon collaris
   b. Chaetodon auriga
   c. Amphiprion percula
   d. Heniochus acuminatus
   e. Abudefduf saxatilis
   f. Pterois volitans
   g. Holocentrus samara

7. Identification of ornamental crustaceans.
8. Identification of ornamental mulluscs.
9. Identification of aquarium plants
    a. Vallisnaria spiralis
    b. Cabomba coroliniata
    c. Ceratoppteris sp.
    d. Sagittaria
    e. Myriophyllum
10. Setting up of aquarium tank – Freshwater and Marine.
11. Breeding and rearing of Guppy – a live bearer.
12. Breeding and rearing of Gold fish – an egg scatterer.
13. Breeding and rearing of Blue gourami – a bubble nest builder.
14. Identification of fish diseases and monitoring fish health.
15. Disease treatment and chemicals.

SEMESTER - III

AFA3T11   Mariculture

AFA3T12   Fish Nutrition

AFA3T13   Microbiology and Quality control

AFA3P14   Aquaculture and Fish Nutrition

AFA3P15   Microbiology and Quality control

AFA3P16   Hatchery Training*

AFA3T11-Mariculture   (90 Hrs)

Unit – 1. Introduction   (5 Hrs)

Scope and Global status of Mariculture. Mariculture in India, Environmental impacts of Mariculture.

Unit – 2. Crustacean culture   (20hrs)

Overview of the crustacean culture in the world. Major species of Spiny lobster, Sand Lobsters, Crabs and Shrimps. Seed production- Natural and Hatchery, Broodstock management, Techniques of Induced breeding. Traditional and modern farming techniques- Extensive, Intensive and Semi intensive. Sea ranching.

Unit – 3 Culture of Molluscan   (25hrs)

Overview of culture of molluscans of the world. Major species of edible oysters, Pearl oysters, Mussles, Clams, Cockles, Scallops, Abalons and Cephalopods used in aquaculture. Broodstock management, induced maturation and spawning. Seed production – Natural seed resources and collection techniques of oysters, Mussles and Clams. Hatchery production of seeds of Oysters mussles and clams. Mussle and Oyster farming – site selection, farm structure and farming techniques. Artificial pearl production techniques. Abalone culture methods, culture of cephalopods. Biofouling in molluscan farms and control measures. Effect of toxic algal blooms.

Unit – 4. Seaweed Culture   (10hrs)

 Taxonomy of Economically important sea weeds. Sea weed morphology, Reproduction and life cycle. Sea weed propagation methods and culture. Sea weed utilization. Importance of sea grasses.

Unit – 5 Culture of Sea cucumber   (10hrs)

Major species of seacucumbers and their distribution. Seed production techniques and Culture methods, Culture of sea cucumbers in India.

Unit – 6 **Culture of Fin fishes** **(20hrs)**

Criteria for selection of fish for mariculture, Broodstock management, breeding under controlled conditions, Induced breeding and egg incubation of cobia, pompano and grouper. Natural seed resources, Collection acclimatization and transportation of seed, Hatchery production of seed. Larval rearing. Different kinds of grow out culture systems. Finfish mariculture in cages, pens and race ways and running water systems.

AFA3T12 FISH NUTRITION   **90 HOURS**

Unit 1 Nutritional Physiology   **(15 hrs)**

Principles of nutrition, Adaptations to various types of feeding in finfish, crustaceans and mollusks; Mechanism of food capture, food ingestion and role of feeding stimulants; Digestion assimilation and conversion of nutrients; Roles of gut microbes in digestion; Nutritional bioenergetics in finfish and shellfish.

Unit 2 Nutritional Requirements   **(25hrs)**

Gross protein requirements; Nitrogen balance; Essential and non-essential amino acids and their quantitative requirements; Protein quality and sources; Lipid – their functions; Essential fatty acids; phospholipid & sterol requirements; Protein sparing action of lipids; Negative aspects of lipids; Carbohydrates – their sources and utilization; Gross energy requirements; Factors altering energy requirements; Water and fat soluble vitamins; Deficiency and hyper dosage syndromes; antivitamin factors; Mineral requirements, importance of minerals; recommended dietary allowances; deficiency and hyper dosage syndromes. Feed additives, proximate composition, apparent digestibility. Antinutritional factors and toxins. Nutritional requirements of brood stock; factors affecting nutritional requirements. Nutritional requirements of cultured species.

Unit 4 Feed Formulation, Manufacture and Quality Control   **(20Hrs)**

Choosing feed ingredients; Feed formulation strategies and methods (Pearson's Square method and algebraic method); Practical formulations for carp, milkfish, tilapia, seabass, giant freshwater prawn, tiger shrimp. Feed manufacture processes- Small scale and Commercial feed manufacture. Storage and quality control of feeds.- factors controlling the feed quality; chemical and biological methods of evaluation. Different grades of feeds; cost effective feed formulations; feed conversion ratio; management of feed mills; economics.

Unit 5 Management of Feeding   **(10Hrs)**

Feeding strategies. Feeding equipments. Feeding rate and frequency. Recording of feeding and monitoring water quality. Feeding of commercially important species like milk fish, tilapia, carp, sea bass, tiger shrimp and Macrobrachium rosenbergi.

Unit 6 Larval Nutrition (15 Hrs)

Nutritional requirements of finfish, crustacean and molluscan larvae; Nutritive value of cladocerans, Copepods and rotifers and their culture. Artemia- Nutritive value, their mass culture and cyst production. Micro diets for larvae; Recent advances in larval nutrition. Method sof collection and culture methods, various medias used in the culture of microalgae- Chaetoceros, Chlorella, Tetraselmis, skeletonema and Isochrysis.

Unit 7 Nutritional Diseases. 5 Hours

Nutritional diseases of cultured varieties of fishes, mollusks and crustaceans and control measures.

REFERENCES

1. Sena S. De Silva and Trevor Anderson. Fish Nutrition in Aquaculture. Chapman and Hall, Publ.
2. Verreth, J. Fish Larval Nutrition. Chapman and Hall, Publ.
3. Stephen Goddard, 1996. Feed Management in Intensive Aquaculture.
4. Farm-made Aquafeeds. FAO Fisheries Technical Paper 343.
5. Devadasan, K. (Ed.)1994. Nutrients and Bioactive substances in Aquatic Organisms.
6. Kalver John, E. 1972. Fish Nutrition. Academic Press, London.
7. Halver John E. and Tiews Klaus, 1979 Finfish Nutrition and Fish Feed Technology. Heenemann, Berlin.
8. Hepher Balfour 1988. Nutrition of Pond Fishes. Cambridge University Press.
9. Tyler Peter and Calow Peter, 1985. Fish Energetics. Croom Helin, London.
10. Winberg, 1960. Rate of Metabolism and Food Requirements in Fishes. Fisheries Research Board of Canada.
11. Shimeno Sadao, 1982. Studies on Carbohydrate Metabolism in Fish. Amerind Publishing Company, New Delhi.
12. Cowey, C.B. et al. (Eds.) 1985. Nutrition and Feeding in Fishes. Academic Press, London

AFA3T13 MICROBIOLOGY AND QUALITY CONTROL   90 HOURS

MICROBIOLOGY   **45 Hours**

Unit 1 Fundamentals and Advanced techniques

1.1 Morphology of bacteria, yeasts and molds.
1.2 Staining of bacteria
      1.2.1   Gram staining
      1.2.2   Acid fast staining
      1.2.3   Bacterial cell staining
1.3 Nutrition of bacteria
1.4 Culture of bacteria
      1.4.1   Culture media and common ingredients
1.5 Environmental effect on bacteria
1.6 Growth phases of bacteria
1.7 Laboratory techniques in bacteriology
1.8 Pure culture techniques
1.9 Isolation and identification of cultured colonies
1.10   Commonly occurring bacteria in marine, brackish water and freshwater environment
1.11   Microbial activity in fish and fishery products
1.12   Microbiology of spoilage and preservation
      1.12.1 Microbial changes during icing, freezing and curing
      1.12.2 Chemical control of microbial spoilage
      1.12.3 Effect of preservatives and antibiotics on microflora
      1.12.4 Growth of resistant microflora
1.13   Scope and importance of industrial microbiology
1.14   Advances in fishery microbiology

QUALITY CONTROL   **45 HOURS**

Unit 2 Quality Control in Seafood Trade

2.1 TQM concept and application

2.2 Quality control and assessment in fish and fishery products

    2.2.1 Organoleptic, Physical, Chemical and Microbiological quality

    2.2.2 Quality standards

    2.2.3 Quality Assurance

2.3 Inspection and Quality Control

    2.3.1 Inspection and Inspection agencies in India

    2.3.2 Process water quality in processing industry

    2.3.3 Product quality

    2.3.4 Water analysis and treatment

        2.3.4.1 Chorination

        2.3.4.2 Ozonization

        2.3.4.3 UV Radiation

        2.3.4.4 Reverse Osmosis

        2.3.4.5 Removal of pesticides and heavy metals

2.4 Sensory evaluation of fishery products

    2.4.1 Different methods of evaluation

    2.4.2 Taste panel selection and constitution

    2.4.3 Statistical Analysis

2.5 Quality Standards and Problems in Fishery Products

    2.5.1 GMP's

    2.5.2 HACCP and ISO 9000 series of quality assurance

    2.5.3 Validation and Audit

    2.5.4 National and International Standards

2.5.5 EU Regulations on Fishery Products Export

2.5.6 IDP and SAT formations in certification of export worthiness of processing units

2.5.7 Regulations for fishing vessels, pre-processing and processing units

2.5.7.1 EU Regulations

2.6 Factory Sanitation and Hygiene

2.6.1 National and International requirements

2.6.2 SSOP

2.7 Hazards in Sea Foods

2.7.1 Seafood toxins

2.7.2 Biogenic amines

2.7.3 Heavy metals and industrial pollutants

REFERENCES

1. Robinson, R.K. (1985) Microbiology of Frozen Foods. Elsevier Applied Science Publishers.
2. Devadasan, K., Mukundan, M.K., Antony, P.D. and Jos Joseph (1994) Nutrients and Bioactive substances in Aquatic Organisms. SOFT(I)
3. James Muil Leitch (1965) International Congress of Food Science and Technology – Biological and Microbiological Aspects of food. Gordon and Breach Science Publishers.
4. Slanetz, L.W., Chichester, C.O., Gaufin, A.R. and Ordal, N.J. (1963) Microbilogical Quality of Foods. Academic Press, New York.
5. Bonnell, A.D. (1994) Quality Assurance in Seafood Processing. Chapman and Hall, USA.
6. Zeuthen, P., Cheftel, J.C., Eriksson, C., Gormley, T.R., Linko, P. and Paullis, K. (1990) Processing and Quality of Foods. Vol. 2 Food Biotechnology. Elsevier Science Publishers Ltd.
7. Heid, J.L. and Maynard A. Joslyn, B.S. (1981) Fundamentals of Food Processing Operations : Ingredients, Methods and Packaging. The AVI Publishing Co. Inc., USA.
8. T.S. Gopalakrishna Iyer, Kandoran M.K., Mary Thomas and Mathew P.T. (2000) Quality Assurance in Seafood Processing. SOFT(I).
9. Hersch Doerfer S.M (Ed.) (1967) Quality Control in Food Industry. Academic Press Inc. London.

10. Jose Miguel Aguilera and David W. Stanley (1990) Micro Structural Principles of Food Processing and Engineering. Elsevier Applied Science, London.

AFA3P14 Aquaculture and Fish Nutrition

1. Dissection of female reproductive system and determination of maturity stages of penaeid prawn .

2. Identification of maturity stages of any one fish (*Mugil cephalus/Lates calarifer/Cyprinus carpio*).

3. Primary productivity based on Dissolved Oxygen method

4. Pituitary isolation and extraction of pituitary hormones.

5. Carp induced breeding using pituitary extract

6. Artemia cyst hatching and harvest.

7. Estimation of pH of Soil

8. Feed formulation using Pearson square method and feed preparation

9. Determination of proximate composition of prepared feed

10. Collection and identification of any six species of cultivable sea weed.

AFA3P15 MICROBIOLOGY AND QUALITY CONTROL

1. Formulation of different media.

2. Practice of standardization and disinfection.

3. Stains and staining techniques.

4. Aerobic and anaerobic culture techniques.

5. Isolation and identification techniques of bacterial culture.

6. Organoleptic tests of fish and fishery products.

7. Estimation of common bacteria of aquatic environment.

8. Estimation of fish spoilage indices.

SEMESTER - IV

AFA4T17   Fisheries business Management

AFA4T18   Fish capture Technology & Management

AFA4T19   Fish Processing technology

AFA4P20   Fish Capture Technology

AFA4P21   Fish Processing Technology

AFA4Pt22   Project**

AFA4Vv23   Viva voce***

AFA4T17 FISHERIES BUSINESS MANAGEMENT   90Hours

UNIT 1 FISHERIES ECONOMICS, TRADE & COMMERCE   25 HOURS

Definition of economics and application of economic principles to fisheries. Special characteristic features of fishery resources as common property resources. Theory of production, law of diminishing returns and risks and profits in fisheries.   **5 hours**

Economics of fish markets, marketing and resource management. Co-operative and their importance in fish production and marketing; export oriented growth policies; fisheries projects and fish resources, institutional and management issues, planning and financing schemes for fisheries.   **5 hours**

Economics of capture and culture fisheries – Cost and earnings of different types of fishing units in marine and inland fisheries. Estimation of break even point and comparative profitability. Investment – autonomous and induced investment. Factors influencing investment decisions. Balance sheet, cash flow analysis, Farm budgeting ratio analysis.   **10 hours**

Trade and exports- export of marine products- trend and present status, tariff and non-tariff barriers. Shipping, insurance, trade control, export policies, export incentives, export documentation procedures. Role of MPEDA and Export Inspection Councils.   **5 hours**

UNIT 2 FISHERIES RESOURCE MANAGEMENT   10 Hours

   2.1 Exploitation and management of Deep Sea Resources

   2.2 Exploitation and Conservation of Coastal Resources

   2.3 Management of brackish water resources

   2.4 Management and conservation of freshwater resources

UNIT 3 HUMAN RESOURCE MANAGEMENT   10 Hours

Manpower planning and recruitment. Performance appraisal of managers in fisheries organisations, organisation development, training and management development, motivation leadership and communication.   **5hours**

Human resources development and its role in the context of fisheries sector, manpower requirements for various activities of the fisheries sector. Raising the required manpower for fisheries developmental programmes. Important institutions involved in human resources development for the fisheries sector.   **5 hours**

UNIT 4 PROCESSING SECTOR MANAGEMENT   10 Hours

4.1 Organizational setup.

4.2 Line and Staff control

4.3 Managerial Functions

4.4 Management Strategy

4.5 Government policies

4.6 Other regulatory organizations

UNIT 5 MARICULTURE MANAGEMENT   20 Hours

Administration and Legal Aspects
Administrative structure at National and State levels
Fisheries research, education and development organizations and their functions
Fishery legislation and regulation
Laws of the Sea
Regulation on industrial effluents
Laws and criteria for land and open water allotment for aquaculture
Planning and Development
Overview of strategies and methods for promoting aquaculture development
Review of planned aquaculture development around the world
Training needs and facilities for aquaculture
Coordination of development and responsibilities of different maritime states
Fish seed syndicates, cooperatives and hatcheries at the state level
Feed and fertilizer availability
Facilities for storage and marketing

Conflict between capture and culture fisheries
Encroachment of nursery grounds
Planning for the future
Management of Hatcheries and Farms
Availability of manpower and skilled labour
Personnel requirements and management
Materials management
Energy requirements and management
Financial management
Water quality management for hatcheries and farms
Project Formulation and Evaluation
Preparation of feasibility reports
Criteria and nature of data input for pond culture
Criteria and nature of data input for cage culture
Criteria and nature of data input for pen culture
Criteria and nature of data input for pilot projects in aquaculture
Criteria and nature of data input for small scale projects in aquaculture
Criteria and nature of data input for commercial projects in aquaculture
Criteria and nature of data input for hatcheries(prawn, finfish and molluscan)
Criteria and nature of data input for fish feed mill.

UNIT 6 PLANNING AND STATEGIES FOR FUTURE FISHERIES DEVELOPMENT   5 Hours

Planning organisations for fisheries. Fisheries development in India during the plan periods. Drawbacks in implementation.

UNIT 7 PROJECT FORMULATION   10 Hours

Project formulation; Process identification; Pre-feasibility - Technical, Economic and Social feasibility; Budgeting appraisal; Techniques of milestones, CPM, PERT, Schedule graphing, Decision making. Social and financial viability indicators - cash income, employment generation, rate of return, DCF, NPV, IRR, Sensitivity Analysis.

REFERENCES

1. Lackey, R.T. L.A. Nielson (1980) Fisheries Management . Blackwell Sci. Publ. Oxford.

2. Jhingran and Srivastava (1983) Fisheries Development in India. Concept Publishing Co. New Delhi, 606p

3. Srivastava and Vathsala (1984) Strategy for development of Inland fisheries resource of India. Concept Publishing Co. New Delhi

4. Panayotou, T. (1982) Management concepts for small scale fisheries Economic and Social aspects. Fisheries Tech. Tech. Pap. No. 228. Rome.

5. Cunningham, D and Whitmarsh, (1985) Fisheries economics, an introduction.

6. IRDC (1982) Aquaculture economic research in Asia.Singapore.

7. Anderson.L. (1977) The economics of fisheries management. John Hopkins.

8. Geoffrey Waugh. Fisheries Management – Theoretical developments and contemporary applications.

9. Ian Chaston. Mangerial effectiveness in fisheries and aquaculture.

10. Colin Clark, W., Bioeconomic modeling and fisheries management.

11. Revin Crean and David Symes (Ed), Fisheries management in crisis.

12. Subba Rao, N., Fisheries development and management in India.

13. Ian Chaston, Business management in fisheries and aquaculture.

14. Rowena Lawson, Economics of fisheries development.

15. Pauly, D. and Murphy, G.I. (Ed), Theory and management of tropical fisheries.

AFA4T18 FISH CAPTURE TECHNOLOGY & MANAGEMENT   90 HOURS

Unit 1 Fishing Craft   **25 Hours**

1.1 FAO Classification; Types of Marine and Inland Fishing Vessels

5hours

1.2 Materials and methods of construction and deck layout of fishing vessels

7hours

1.3 Marine Diesel Engines and determinants in selection.

5hours

1.4 Biofouling, Corrosion and Maintenance

5hours

1.5 Marine Propulsion Systems

3hours

Unit 2 Fishing Gears   **25 Hours**

2.1Classification of fishing gears.   3Hours

2.2 Fisheries Hydrography : Effect of environmental stimuli (temperature, light, current, chemical environmental factors) on fish behaviour, Influence of upwelling on distribution of fish, Nature of bottom in relation to fish and fishing, Relation between fish and its food in the sea, Influence of Meteorological factors on fish and fishing.

4Hours

2.3 Principles and methods of capture for different fishing gears.

4Hours

2.4 Natural and Synthetic fishing gear materials and principles of construction

4Hours

2.5 Design and construction of active and passive commercial fishing systems

6Hours

2.6 Fishing accessories – Fishing gear accessories; Hooks and Baits; Fishing Rods; Fish finding devices

4Hours

Unit 3 Navigation, Seamanship and Rope work   **20 Hours**

Navigation   **10Hours**

3.1 Introduction; Navigation charts and Chart work

3hours

3.2 Navigation Communication : Distress-Urgency-Safety Calls, Transmission Procedure, Control of Distress Traffic, Distress Signals, International Code of Signals (Signal flags)   2hours

3.3 Navigation Essentials : Weather forecasts from daily observations; Sky and Weather Notation – Beaufort's Weather Notation, Beaufort's Wind Scale; Lights and Shapes;   3hours

3.4 Modern Techniques : Pilotage, Celestial Navigation, Radio Navigation, Radar Navigation, Satellite Navigation.   2hours

Seamanship and Ropework   **10Hours**

3.5 Ropework   2hours

3.6 Ship handling and anchoring procedures   2hours

3.7 First Aid and Safety; Firefighting procedures   4 hours

3.8 Response to Emergency   2hours

Unit 4 Capture Fisheries Management   **20 Hours**

4.1 Principles of capture fisheries resource conservation and management   5Hours

4.2 Resource Conservation Devices – BRD, TED, FAD   3Hours

4.3 Remote Sensing and its applications   4Hours

4.4 GIS in Fisheries   4Hours

4.5 Energy Optimization in Fishing   4Hours

REFERENCES

1. Hilmar Kristjonsonn (Ed.) Vol 1 (1962), Vol 2 (1964) Vol. 3 (1971) Modern Fishing Gears of the World 3. Fishing News Books Ltd. England.

2. Jan-Olof- Traung (Ed.) Vol 1 (1955), Vol 2 (1966) Vol. 3 (1967).Fishing Boats of the World. Fishing News Books Ltd. England.
3. Subbarao, Mechanization of marine fisherman.
4. Srivastava, Impact of mechanization on small fishermen.

AFA4T19 FISH PROCESSING TECHNOLOGY   90 HOURS

Unit 1 Freezing and Frozen Storage   20 Hours

1.1 Freezing curves for fish
1.2 Determination of freezing points from time-temperature plots
1.3 Calculation of freezing time
1.4 Crystallization
1.5 Nucleation
      1.5.1   Homogenous and Heterogeneous nucleation
1.6 Super cooling
1.7 Eutectic point
1.8 Changes during freezing
1.9 Technical aspects
      1.9.1   Comparison of various methods of freezing
      1.9.2   Chemical treatment prior to freezing
            1.9.2.1 Antioxidants
            1.9.2.2 Cryoprotectants
                  1.9.2.2.1   Mechanism of freezing injury and cryoprotection
            1.9.2.3 Other additives
      1.9.3   Glazing
1.10   Frozen Storage
      1.10.1 Physical Changes
            1.10.1.1   Freezer burn and recrystallization
            1.10.1.2   Different types of recrystallization
      1.10.2 Chemical Changes
            1.10.2.1   Theories of denaturation
            1.10.2.2   Lipids, proteins, nucleotides, freeze denaturation
            1.10.2.3   Changes in pH
      1.10.3 Bacterial Changes
      1.10.4 Sensory Changes
            1.10.4.1   Texture, taste and odour
            1.10.4.2   Effect of post mortem condition on sensory qualities
      1.10.5 Temperature and duration of storage on quality and shelf life
      1.10.6 Frozen marine products export from India

Unit 2 Thermal Processing and Packing   20 Hours

2.1 Principles of thermal processing

2.2 Mechanism of heat transfer

      2.2.1 Conduction

      2.2.2 Convection

      2.2.3 Radiation

      2.2.4 Dielectric and Microwave heating

      2.2.5 Unsteady state transfer

2.3 Heat resistance of bacteria and spores

2.4 Decimal reduction time

2.5 Thermal death time

2.6 "Z" and "F" values

2.7 Heat penetration

2.8 Determination of process time

2.9 Significance of thermal death curve

2.10 Fo value, cook value, D value and integrated F value and significance

2.11 Canning

      2.11.1 Absolute, Statistical and Commercial sterility

      2.11.2 Pasteurization Vs Sterilization

      2.11.3 Canning process

            2.11.3.1 Steps

            2.11.3.2 Process flow

            2.11.3.3 Additives

            2.11.3.4 Different types of cans

            2.11.3.5 Value added canned products

2.11.3.6 Spoilage of canned foods

2.11.3.6.1 Physical spoilage

2.11.3.6.2 Chemical spoilage

2.11.3.6.3 Microbial spoilage

2.11.3.7 Examination of cans and seams

2.12 Retort pouch processing of fish and fishery products

2.13 Irradiation preservation

2.14 Packaging and packaging materials in fish processing

Unit 3 Fishery By-products   **20 Hours**

3.1 Fish meal

3.2 Fish body and liver oils

3.3 By-products of shark

3.4 Utilization of shrimp waste and squilla

3.5 Utilization of Krill

3.6 Fish protein concentrate

3.7 Sea weed by-products

3.8 Fish silage

3.9 Fish Hydrolysates

3.10 Miscellaneous by-products and recent advances

Unit 4 Curing and Dehydration   **20 Hours**

4.1 Principles of drying and dehydration

4.2 Different types of dryers

4.2.1 Tunnel dryer

4.2.2 Vacuum dryer

4.2.3 Drum dryer

4.2.4 Solar dryer

4.3 Freeze drying

4.3.1 Accelerated freeze drying and applications

4.4 Dehydration of fish products

4.4.1 Dehydration ratio

4.4.2 Precautions in fish drying

4.4.3 Denaturation of fish protein

4.5 Spoilage of dried fish and control

4.6 Curing of fish

4.6.1 Salt curing

4.6.1.1 Type and size of salt crystals

4.6.1.2 Factors affecting salt uptake by fish

4.6.1.3 Sources and impurities in salt

4.6.1.4 Methods

4.6.1.4.1 Dry/kench/wet salting

4.6.1.4.2 Pickling

4.6.1.4.3 Brine salting

4.6.1.5 Spoilage of salt cured fish and control measures

4.6.2 Smoke curing

Unit 5 Value Addition   **10 Hours**

5.1 Marinades

5.2 Fish and shellfish pickles

5.3 Fermented fish products

5.4 Fish sauces

5.5 Recent advances

REFERENCES

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5. Kreuzer, R. (Ed) Fishery products. Fishing News England.

6. Greensmith, M Practical Dehydration. Food Trade Press.

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9. Charles Cutting, L., Fish processing and preservation. AGRO Botanical Publishers (India).

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AFAP20 FISH CAPTURE TECHNOLOGY

1. Basic principles of gear design and construction
   a. Mesh size measurements
   b. Shape Cutting
      i. Baiting
      ii. Creasing
      iii. Tailoring
      iv. Fly Meshing
   c. Hanging Coefficient
   d. Mounting – Different methods.
2. Mending of nets
3. Preparation of glossary on fishing craft and gear (around 100 terms)
4. Navigation
   a. Identification of Signal Flags
   b. Chartwork exercises
   c. Boat recognition and Ship recognition
   d. Sea measurement calculations
5. Seamanship and Ropework
   a. Wound dressing and bandaging
   b. Use of splints in fractures
   c. Fabrication of stretcher
   d. Cardiopulmonary Resuscitation
   e. Ropework excercises – Identification of ropes : Twisted ropes, Braided ropes and Combination ropes; Fabrication of Ropes; Knots and Splices.
6. Fabrication and installation of FAD.

Life Skill Attainment: Training in Swimming and Diving

AFAP21 FISH PROCESSING TECHNOLOGY

1. Filleting of fish, treatments, glazing, packaging and freezing.

2. Frozen storage studies.

3. Canning of tables fishes, bivalves and crustaceans in different containers.

4. Examination of canned fishery products.
   a. Can seams
   b. Testing sterility

5. Preparation of fish meal, FPC, fish oils, chitin, chitosan, glucosamine hydrochloride, fish maws, isin glass, agar, alginic acid etc.

6. Preparation of feeds, encapsulation, experimental diets, nutritional evaluation, biochemical composition, evaluation of FCR and PER of feeds.