UNDER GRADUATE
COURSE CATALOGUE
2025

CHAUDHARY CHARAN SINGH HARYANA AGRICULTURAL UNIVERSITY HISAR-125004

(A+ Grade NAEAB-ICAR ACCREDITED)

Foreword

It gives me immense pleasure to present the Undergraduate Academic Catalogue of Chaudhary Charan Singh Haryana Agricultural University, Hisar, developed in adherence to the academic guidelines laid down by the Indian Council of Agricultural Research (ICAR) and the holistic vision of the National Education Policy 2020 (NEP 2020).

This catalogue encompasses a wide array of undergraduate programmes-B.Sc. (Hons.) Agriculture, B.Sc. (Hons.) Agribusiness Management, B.Tech. (Agricultural Engineering), B.Tech. (Biotechnology), B.Sc. (Hons.) Community Science and B.F.Sc. reflecting our institution's comprehensive and forward-looking approach to agricultural education.

Rooted in academic excellence and enriched with hands-on learning, the curriculum is crafted to develop skilled, innovative and socially responsible professionals. The NEP 2020's emphasis on multidisciplinary education, flexibility and learner-centric models is well-embedded in the structure of this catalogue. It is designed to empower students with critical thinking, entrepreneurial aptitude, ethical grounding and global awareness-traits essential for addressing the challenges and opportunities of the 21st century agri-food systems.

As we move toward a future of sustainable agriculture, climate resilience and technological integration, this academic catalogue stands as a guiding document that aligns education with employability, research with relevance and tradition with transformation.

I congratulate the all contributing faculty members, Dr. S.K. Pahuja (Dean, College of Agriculture and College of Agricultural Engineering & Technology), Dr. Beena Yadav (Dean, College of Community Science), Dr. K.D. Sharma (Dean, College of Biotechnology), Dr. Rajesh Gera (Dean, College of Basic Sciences & Humanities and College of Fisheries Science), Dr. Atul Dhingra, OSD to Vice-Chancellor and Head, Business Management and Dr. Mukesh Kumar, Associate Professor, Dept. of Genetics and Plant Breeding, College of Agriculture for their dedication, vision and hard work in preparing this catalogue. It will undoubtedly serve as a valuable academic compass for our students, educators and stakeholders.

Prof. B.R. Kamboj

Prof. B.R. Kamboj
Vice-Chancellor
CCSHAU, Hisar

Preface

I am delighted to present the Undergraduate Academic Catalogue of CCS Haryana Agricultural University, Hisar, meticulously prepared in alignment with the guidelines of the Indian Council of Agricultural Research (ICAR) and the National Education Policy 2020 (NEP 2020). This catalogue outlines the structure, curriculum and academic framework of our diverse undergraduate programs-B.Sc. (Hons.) Agriculture, B.Sc. (Hons.) Agribusiness Management, B.Tech. Agricultural Engineering, B.Tech. Biotechnology, B.Sc. (Hons.) Community Science and B.F.Sc. The course catalogue and examination and evaluation system as per the recommendations of the Sixth Deans' Committee of ICAR and will be implemented from academic session 2025-26 of 4-year programme of all the colleges.

In tune with the vision of NEP 2020, this catalogue embodies a holistic and multi disciplinary approach, aiming to nurture critical thinking, practical skills, ethical grounding and entrepreneurial spirit among our students. The curriculum emphasizes experiential learning, skill development, and industry alignment, ensuring that our graduates are not only academically sound but also socially responsible and globally competent.

Each program has been thoughtfully designed to balance foundational knowledge with emerging scientific advancements, integrating local relevance with global perspectives. Special emphasis has been placed on internships, rural and industry exposure, interdisciplinary electives, and innovation-driven projects to foster creativity and real-world problem-solving abilities in our students.

This catalogue is a testament to our commitment to academic excellence, student-centric learning, and nation-building through quality education in agriculture and allied sciences. I sincerely hope it serves as a valuable guide for our students, faculty, and stakeholders, and contributes to shaping the next generation of agricultural professionals and leaders.

I acknowledge the dedicated efforts of Dr. Beena Yadav (Dean, College of Community Science), Dr. K.D. Sharma (Dean, College of Biotechnology), Dr. Rajesh Gera (Dean, College of Basic Sciences & Humanities and College of Fisheries Science), Dr. Atul Dhingra, OSD to Vice-Chancellor and Head, Business Management, Dr. Mukesh Kumar, Associate Professor, Dept. of Genetics and Plant Breeding, Dr. Anil Kumar, Sr. Scientist & Head, Dept. of Nematology, Dr. Subodh Aggarwal, Assistant Professor, Dept. of Business Management, Dr. Lomash Kumar, Assistant Professor, Dept. of Entomology, Dr. Neelam M. Rose, Professor & Head, Dept. of Apparel & Textile Science , Dr. Saroj Yadav, Associate Professor, Dept. of Apparel & Textile Science, Dr. Rachna Gulati, Professor, Dept. of Aquaculture & Post harvest Technology, Dr. Anupam Anand, Assistant Professor, Dept. of Fisheries Extension, Economics & Statistics, Dr. Kavita Sharma, Assistant Professor, Dept. of Fisheries Resource Management, Dr. Rajender Kumar, Assistant Professor, Dept. of Basic Engineering, Dr. Ajeev Kumar, Assistant Professor, Dept. of Agricultural Biotechnology and Dr. Kanika Rani, Assistant Professor, Dept. of Nanobiotechnology for curriculum development, revision and compilation of under graduate course curriculum of the university.

The help extended by Registrar, Dean, PGS, Directors and Officers of the university, the Head of departments and faculty members involved in the preparation of this document is gratefully acknowledged.

Dr. S. K. Pahuja

Dr. S. K. Pahuja
Dean, College of Agriculture
&
Chairperson
Committee for finalisation
of UG Course Curriculum
CCS HAU, Hisar

ACRONYMS

AAHM	Aquatic Animal Health Management
ABM	Agricultural Business Management
ABT	Agricultural Biotechnology
AE	Agricultural Engineering
AEC	Ability Enhancement Course
AEM	Aquatic Environment Management
AGRI	Agriculture
AIA	Agro-Industrial Attachment
AM	Agribusiness Management
ANBT	Animal Biotechnology
ATS	Apparel and Textile Science
AGRON	Agronomy
AG ECON	Agricultural Economics
AGM	Agricultural Meteorology
AQC	Aquaculture
BI	Bioinformatics
BIO	Biology
BIOCHEM	Biochemistry
BIOTECH	Biotechnology
CCA	Co-curricular Activity
CE	Civil Engineering
CS	Community Science
COMP	Computer Science
EE	Electronics and Electrical Engineering
EECM	Extension Education and Communication Management
ENG	English
ENT	Entomology
EXT	Extension Education
FE	Fish Engineering
FN	Foods and Nutrition
FEES	Fisheries Extension, Economics & Statistics
FMPE	Farm Machinery & Power Engineering
FOR	Forestry
FPT	Fish Processing Technology
FRM	Fisheries Resource Management
FS	Fisheries Science
GPB	Genetics & Plant Breeding
HDFS	Human Development and Family Studies
HORT	Horticulture
IBT	Industrial Biotechnology
LPM	Livestock Production Management
MATH	Mathematics

MBB	Molecular Biology & Biotechnology
MDC	Multi-Disciplinary Course
ME	Mechanical Engineering
MEB	Microbial and Environmental Biotechnology
MICRO	Microbiology
NBT	Bio-Nanotechnology
NCC	National Cadet Corps
NEMA	Nematology
NG	Non Gradial
NSS	National Service Scheme
PBT	Plant Biotechnology
PFE	Processing and Food Engineering
PL PATH	Plant Pathology
PL PHY	Plant Physiology
RAWE	Rural Agricultural Work Experience
REE	Renewable Bio-energy Engineering
RMCS	Resource Management and Consumer Science
SEC	Skill Enhancement Course
SOC	Sociology
SOILS	Soil Science
SST	Seed Science & Technology
STAT	Statistics
SWE	Soil and Water Engineering
TUT	Tutorial
VAC	Value Added Course
VSC	Vegetable Science

CONTENTS

GENERAL INFORMATION

Chaudhary Charan Singh Haryana Agricultural University, Hisar has revised Course Curriculum for undergraduate programmes in all the colleges of the University as per the recommendations of the Sixth Deans' Committee of ICAR and implemented from academic session 2025-26.

- The B.Sc. (Hons.)/ B.F.Sc./ B.Tech. programme are of 4 years duration, covering 166-174 credits of coursework. Additionally, students engage in 16 credits of non-gradial courses and 10 credits of MOOCs/online courses. The credit distributions for the different courses have been specified for individual disciplines.

General Credit Allocation Scheme of UG Programmes

Semester	Core Courses (Major+ Minor)	Multi-Disciplinary Courses (MDC)	Value Added Courses (VAC)	Ability Enhancement Courses (AEC)	Skill Enhancement Courses (SEC)	Internship/ Project/ Student READY/ RAWE & AIA	Total Credits	Non-Gradial	Online Courses/ MOOC
I	12	3(2)	-	2(3) + 2(4)	4	-	23	3(1+1a)	10
II	10	3(5)	3(6)	2(3) + 2(7)	4	-	24	2(1a+8a)	
Post-II semester	-	-	-	-	-	10(12)	-	-	
III	16	-	-	2(8)	2	-	20	3(3+1a)	
IV	12	3(9)	3(10)	-	2	-	20	2(1a+8a)	
Post-IV semester	-	-	-	-	-	10(13)	-	-	
V	21	-	-	-	-	-	21	5(3+1a+11)	
VI	21	-	-	-	-	-	21	1(1a)	
VII	20	-	-	-	-	-	20	-	
VIII	-	-	-	-	-	20	20	-	
Total	**112**	**9**	**6**	**10**	**12**	**20**	**169**	**16**	**10**

(1) Deeksharambh (Induction-cum-Foundation Course) of 2 credits (2 weeks duration)
(1a) Tutorial
(2) Farming based Livelihood systems
(3) NCC/NSS
(4) Communication Skills
(5) Entrepreneurship Development and Business Management
(6) Environmental Studies and Disaster Management
(7) Personality Development
(8) Physical Education, First Aid, Yoga Practices and Cultural Activities
(8a) Co-curricular Activity
(9) Agriculture Marketing and Trade
(10) Agriculture Informatics and Artificial Intelligence
(11) Educational Tour (10-14 days)
(12) Only for those opting for an exit with UG-Certificate
(13) Only for those opting for an exit with UG-Diploma

One multidisciplinary course in Agricultural Engineering discipline is different from the above common courses keeping in view the discipline specific requirement.

UNDERGRADUATE PROGRAMMES COLLEGE-WISE

Programme	Core Courses (Major+ Minor)	Multi-Disciplinary Course (MDC)	Value Added Course (VAC)	Ability Enhancement Course (AEC)	Skill Enhancement Course (SEC)	Internship/ Project/ Student READY/ RAWE & AIA	Total Credits	Non-Gradial	Online Courses/ MOOC
B.Sc. (Hons.) Agriculture	112	9	6	10	12	20	169	17	10
B.Sc. (Hons.) Agribusiness Management	112	9	6	8	12	20	167	17	10
B.Tech. (Agricultural Engineering)	125	10	6	10	8	15	174	18	6
B.Tech. (Biotechnology)	112	9	6	8	12	20	167	16	10
B.Sc. (Hons.) Community Science	112	9	6	10	12	20	169	16	10
B.F.Sc.	117	9	6	8	12	20	172	16	10

- After the admission in the University, the students will register for *Deeksharambh* (0+2) (Non-gradial) the Foundation course of 2 weeks' duration in the 1st semester of the degree programme. It will include discussions on operational framework of academic process in the college and the university. There will be sessions with alumni, business leaders, University academic and research personnel on instilling social awareness, ethics and values, cultural heritage, folk art and craft, Indian Constitution etc. It will help to identify the strength and weakness of students, diverse potentialities and to enhance cultural integration of students from different backgrounds. It will also create a platform for students to learn from each other's life experiences.
- The first year of the degree programme comprises skill development courses/ modules along with other fundamental courses. After satisfactory completion of courses in two semesters of 1st year and subsequent satisfactory completion of 10 credits (10 weeks) of industry/ institute training/ internship, the student will become eligible for the award of UG-Certificate in admitted programme on exit. The students continuing the study further, would not have to attend the internship after 1st year.
- The second year has been designed with the skill development courses as well as fundamental courses related to degree programme with adequate theory and practical components, enabling the student to get acquainted with the basic principles and applications of agricultural sciences. After satisfactory completion of the courses during first two years and subsequent satisfactory completion of 10 credits (10 weeks) of internship/industry/institute training, the student will become eligible for the award of UG-Diploma in the admitted programme on exit. The students continuing the further study, need not to attend the internship after 2nd year. However, the students of B.Tech (Agricultural Engineering) are being offered 4 weeks In-Plant training as partial credits

after 4th Semester during break for completing the degree requirement with splitting in two slots (4 weeks each).

- The courses in the third year have been designed to impart in-depth knowledge of the subject to the students. There will not be an exit after 3rd year. During 5th semester, the students will have an educational tour of 10-12 days duration, which will be counted as 2 credits (Non-gradial).
- The fourth year of degree programmehas been meticulously designed not only to impart specialized knowledge to the students in the selected major disciplines but also to prepare the students to take up employment or entrepreneurship as their future career.
- During the 7th semester, the students will adequately select 20 credits from a basket of elective courses, each course giving an opportunity to gain advanced knowledge in frontier areas of science. The objective is to enable the student to acquire deeper understanding in any particular field.
- In the 8th semester of the degree programme, Student READY programme: Rural Agricultural Work Experience (RAWE), Experiential Learning, Hands-on Training, In-plant Training/ Industrial Aattachment/Internship and Project Work of 20 credits will be offered.
- In B.Tech (Agricultural Engineering) final year, the student will have the liberty to choose any three elective subjects, preferably from one or related disciplines. The objective is to enable the student to acquire deeper understanding in a particular field. In the final year, the Project-I (3 credits in 7th semester) and Project-II (4 credits in 8th semester) are meant for advanced skill development for research, employment and entrepreneurship. Under these courses, the student will have the option to take up a research project (R & D based/field study based) for developing research skills in form of project or take up incubation/ experiential learning-based activity for entrepreneurship development. The Project-I and II can also be taken up in collaboration with any organization/ industry.
- The students have to take a minimum of 10 credits of online courses (6 credits for B.Tech Agricultural Engineering) during four years as a partial requirement for the B.Sc. (Hons)/ B.F.Sc./B.Tech. programme. The online courses can be from any field such as Agriculture and allied sciences, Basic Sciences, Humanities, Psychology, Anthropology, Economics, Business Management, Languages including foreign language, Communication skills/ Music, etc. and can be taken from NPTEL, Mook IT, edX, Coursera, SWAYAM or any other such reputed portal accepted by the University. The objective is to allow the students to groom their passion or strengthen their knowledge and competency in any field beyond prescribed courses. These online courses will be non-gradial and separate certificates would be issued by institute/organization offering the courses. The student must submit the list of online courses along with the content he/she intends to undertake to the Dean/Assoc. Dean/Principal of the college for a permission and records.

Entry and Exit Options

The entry and exit options for the UG programme is shown in the figure below.

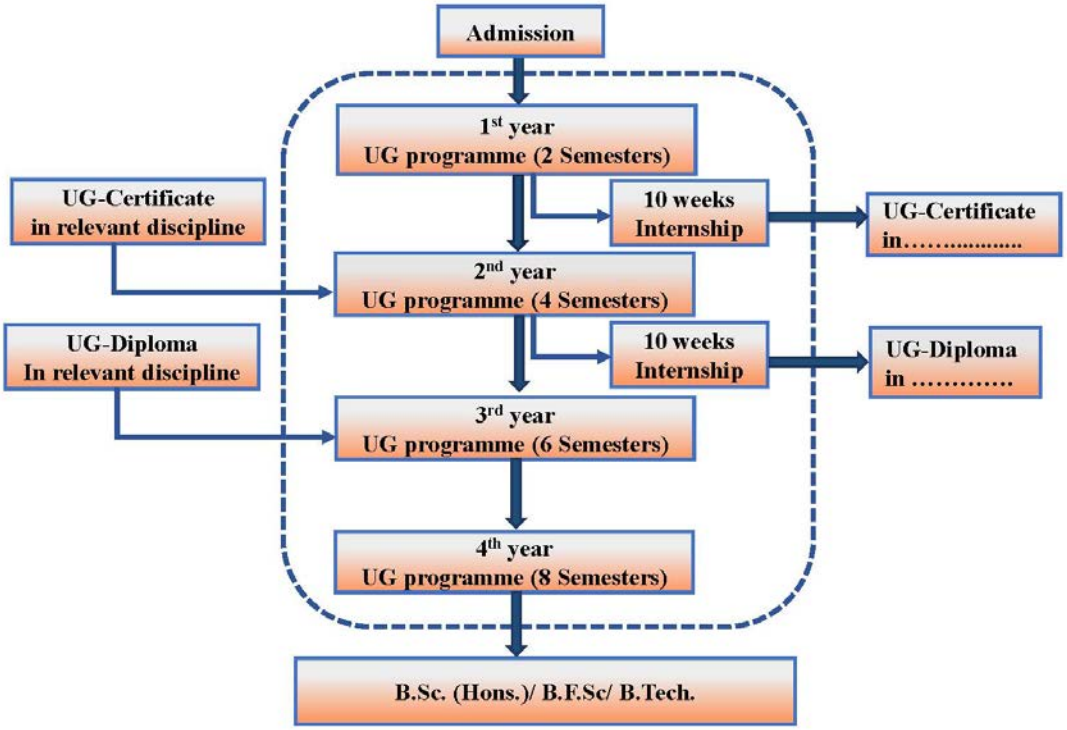


Figure 1: Entry and Exit Options for the UG Programmes

Entry Options: Students with UG-Certificate and UG-Diploma can take admission in 2nd and 3rd year, respectively of B.Sc.(Hons.)/ B.F.Sc./ B.Tech. degree programme.

Exit options

i. **UG-Certificate:** Exit after satisfactory completion of first year and 10 weeks' internship.

ii. **UG-Diploma:** Exit after satisfactory completion of second year and 10 weeks' internship.

iii. **B.Sc. (Hons.)/B.F.Sc./B.Tech.:** On successful completion of four-year degree requirements.

Examination and Evaluation System

Examination and evaluation system of under graduate programme of the University has been given below:

- External pattern of examination shall be followed only for the final theory portion to be conducted at the end of the semester for regular courses.
- External theory exam will be 50% and internal theory + practical- 50%.
- There will be mid-term examination for internal theory and evaluation will be internal.

- The question papers for non-credit courses will be set at the level of Dean/HOD concerned.
- The mid-term, practical and final-term examination shall be conducted during examination dates prescribed in the academic calendar.
- The date sheet will be provided by the Dean of the respective colleges.
- For a course with practical only, practical examination will be conducted twice during mid-term and final term.

Distribution of Marks for Various Examinations

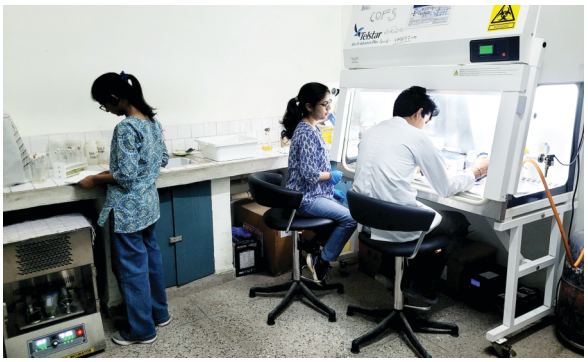
Nature of courses Credit Hours (Theory + Practical)	**Internal (100)**				**External (100)**
	Mid-term Theory	**Assignment**	**Mid-term Practical**	**Final Practical**	
Courses with theory and practical					
1+1	30	20	NA	50	100
1+2	20	20	NA	60	100
2+1	40	20	NA	40	100
2+2	30	20	NA	50	100
3+1	50	20	NA	30	100
Courses with only theory	70	30	NA	NA	100
Courses with only practical	NA	30	70	100	NA

- After adding marks of all the examinations, the total will be divided by two for converting total marks out of 100 and combined (Theory + Practical) grade of each course will be awarded.
- The evaluation of the skill enhancement courses will be done as courses with practical only.
- Usually for any subject, there will be two assignment/quizzes within the semester, one before the midterm and one after midterm examination.
- The evaluation of internship will be done by the parent institute. The student shall submit a report to the parent institute and present the learnings before the other students and faculty after the internship programme.
- The online/MOOC courses, successfully completed by the student, will be indicated in the transcript with 'Satisfactory' grade.
- When students take deficiency course(s), they will be assessed as 'Satisfactory' or Unsatisfactory' without any grade points.

The course catalogue and examination & evaluation system as per the recommendations of Sixth Deans' committee implemented with effect from academic year 2025-26, starting from 1st year 4-year programme of all the colleges. In rest of the existing classes (2nd to 4th year 4-year programme) of all the colleges, the old course catalogue and examination system shall be followed.

COLLEGE OF FISHERIES SCIENCE









COLLEGE OF FISHERIES SCIENCE

B.F.SC. 4-YEAR PROGRAMME

COURSES: SEMESTER-WISE

Course No.	Course Title	Credits
	I Semester	
FS 100	*Deeksharambh* (Induction-cum-Foundation course of 2 weeks)	2 (0+2) NG
AQC 101	Freshwater Aquaculture	3 (2+1)
AAHM 101	Fundamental Microbiology	2 (1+1)
AEM 101	Soil and Water Chemistry	3 (2+1)
AEM 102	Meteorology and Geography	2 (1+1)
FRM 101	Taxonomy of Commercially Important Fish and Shellfish	3 (1+2)
SEC I	Skill Enhancement Courses I*	2 (0+2)
SEC II	Skill Enhancement Courses II*	2 (0+2)
AGRON 101 (MDC)	Farming Based Livelihood Systems	3 (2+1)
ENG 101 (AEC)	Communication Skills	2 (1+1)
NCC I/ NSS I (AEC)	National Cadet Corps I/ National Service Scheme I	2 (0+2)
TUT	Tutorial	1 (1+0) NG
	Total Credits	**24 (10+14)**
	II Semester	
AQC 104	Fish and Shellfish Breeding and Hatchery Management	3 (2+1)
AEM 103	Limnology	2 (1+1)
FEES 102 (MDC)	Fisheries Entrepreneurship Development and Business Management	3 (2+1)
FEES 103 (AEC)	Personality Development	2 (1+1)
FRM 102	Anatomy and Biology of Finfish and Shellfish	3 (2+1)
FRM 103	Physiology of Finfish and Shellfish	3 (2+1)
SEC III	Skill Enhancement Courses III*	2 (0+2)
SEC IV	Skill Enhancement Courses IV*	2 (0+2)
SOILS 102 (VAC)	Environmental Studies and Disaster Management	3 (2+1)
NCC II/ NSS II (AEC)	National Cadet Corps II/ National Service Scheme II	2(0+2)
CCA 102	Co-curricular Activity	1(0+1) NG
TUT	Tutorial	1 (1+0) NG
	Total Credits	**25 (12+13)**
FS 200	Internship (10 weeks) Compulsory for students opting for an exit with UG-Certificate after 1st Year	10 (0+10)

III Semester		
AQC 201	Coastal Aquaculture and Mariculture	3 (2+1)
AQC 202	Fish Nutrition and Feed Technology	3 (2+1)
FE 201	Fishing Craft Technology	2 (1+1)
FEES 201	Fisheries Extension	2 (1+1)
FPT 201	Fundamentals of Biochemistry and Food Chemistry	2 (1+1)
FPT 202	Post-Harvest Handling and Preservation	3 (2+1)
FRM 201	Inland Fisheries	2 (1+1)
SEC V	Skill Enhancement Courses V*	2 (0+2)
NCC III/ NSS III	National Cadet Corps III/ National Service Scheme III	2 (2+0) NG
CCA 201 (AEC)	Physical Education, First Aid, Yoga Practice and Cultural Activities	2 (0+2)
TUT	Tutorial	1 (1+0) NG
	Total Credits	**21 (10+11)**
IV Semester		
AQC 205	Breeding and Culture of Ornamental Fish	2 (1+1)
AQC 206	Live Food Organisms for Fish and Shellfish	2 (1+1)
AAHM 201	Fish and Shellfish Diseases and Treatment	3 (2+1)
FE 202	Fishing and Gear Technology	3 (2+1)
FEES 203 (MDC)	Agricultural (Fisheries) Marketing and Trade	3 (2+1)
FPT 205	Fish Products, By-products, Value Addition and Waste Management	3 (2+1)
FRM 202	Marine Fisheries	2 (1+1)
SEC VI	Skill Enhancement Courses VI*	2 (0+2)
COMP 202 (VAC)	Agricultural Informatics and Artificial Intelligence	3 (2+1)
CCA 202	Co-curricular Activity	1 (0+1) NG
TUT	Tutorial	1 (1+0) NG
	Total Credits	**23 (13+10)**
FS 300	Internship (10 weeks) Compulsory for students opting for an exit with UG-Diploma after 2nd Year	10 (0+10)
V Semester		
AQC 301	Fish Genetics and Breeding	2 (1+1)
AAHM 301	Pharmacology and Toxicology	3 (2+1)
AEM 301	Marine Biology	2 (1+1)
AEM 302	Aquatic Ecology and Biodiversity	2 (1+1)
FE 301	Aquaculture Engineering	3 (2+1)
FEES 301	Fisheries Economics	3 (2+1)
FPT 301	Fish Freezing Technology	2 (1+1)

FPT 302	Fish Canning Technology and Packaging	2 (1+1)
FRM 301	Fish Population Dynamics and Stock Assessment	2 (1+1)
FS 351	Educational Tour	2 (0+2) NG
NCC IV/ NSS IV	National Cadet Corps IV/ National Service Scheme IV	2 (0+2) NG
TUT	Tutorial	1 (1+0) NG
	Total Credits	**21 (12+9)**
VI Semester		
AQC 302	Fish Biotechnology and Bioinformatics	2 (1+1)
AAHM 302	Fish Immunology	2 (1+1)
AAHM 303	Therapeutics in Aquaculture	2 (1+1)
AEM 303	Coastal Zone Management	2 (1+1)
FE 302	Refrigeration and Equipment Engineering	2 (1+1)
FE 303	Navigation and Seamanship	2 (1+1)
FEES 302	Statistical Methods	3 (2+1)
FEES 303	Fisheries Policy and Laws	1 (1+0)
FEES 304	Fisheries Co-operative and Marketing	2 (1+1)
FPT 303	Microbiology of Fish and Fisheries Products	2 (1+1)
TUT	Tutorial	1 (1+0) NG
	Total Credits	**20 (11+9)**
VII Semester		
	Elective Courses (Major)#	12
	Elective Courses (Minor)##	8
	Total Credits	**20**
VIII Semester		
FS 499	Student READY (In-plant/ Industry Attachment, Rural Fisheries Work Experience (RFWE), Experiential Learning Programme (ELP), Project Work and Seminar)	20 (0+20)
	Total Credits	**20 (0+20)**
Online Courses (MOOC)**		10 (0+10)
	Grand Total	**172+ 10 (MOOC) +16 NG**

* From the basket of Skill Enhancement Courses
**Online Courses
Students have option to choose any Four Major Courses (12 credits) from the list of courses
Students have option to choose any Four Minor Courses (08 credits) from the list of courses

B.F.SC., 4 YEAR PROGRAMME
FOUNDATION AND COMMON COURSES

Course No.	Course Title	Credits	Semester
FOUNDATION COURSES			
FS 100	*Deeksharambh* (Induction cum Foundation Course of 2 weeks)	2 (0+2) NG	I
FS 351	Educational Tour	2 (0+2) NG	V
	Total Credits	**4 (0+4) NG**	
COMMON COURSES			
Multidisciplinary Courses (MDC)			
AGRON 101 (MDC)	Farming Based Livelihood Systems	3 (2+1)	I
FEES 102 (MDC)	Fisheries Entrepreneurship Development and Business Management	3 (2+1)	II
FEES203(MDC)	Agricultural (Fisheries) Marketing and Trade	3 (2+1)	IV
	Total Credits	**9 (6+3)**	
Value Added Courses (VAC)			
SOILS 102 (VAC)	Environmental Studies and Disaster Management	3 (2+1)	II
COMP 202 (VAC)	Agricultural Informatics and Artificial Intelligence	3 (2+1)	IV
	Total Credits	**6 (4+2)**	
Ability Enhancement Course (AEC)			
ENG 101 (AEC)	Communication Skills	2 (1+1)	I
FEES 103 (AEC)	Personality Development	2 (1+1)	II
NCC I/ NSS I (AEC)	National Cadet Corps I/ National Service Scheme I	2 (0+2)	I
NCC II/ NSS II (AEC)	National Cadet Corps II/ National Service Scheme II	2 (0+2)	II
CCA 201 (AEC)	Physical Education, First Aid, Yoga Practices and Cultural Activities	2 (0+2)	III
	Total Credits	**10 (2+8)**	

B.F.SC., 4 YEAR PROGRAMME

CORE COURSES: DEPARTMENT-WISE

Course No.	Course Title	Credits	Semester
Aquaculture			
AQC 101	Freshwater Aquaculture	3 (2+1)	I
AQC 104	Fish and Shellfish Breeding and Hatchery Management	3 (2+1)	II
AQC 201	Coastal Aquaculture and Mariculture	3 (2+1)	III
AQC 202	Fish Nutrition and Feed Technology	3 (2+1)	III
AQC 205	Breeding and Culture of Ornamental Fish	2 (1+1)	IV
AQC 206	Live Food Organisms for Fish and Shellfish	2 (1+1)	IV
AQC 301	Fish Genetics and Breeding	2 (1+1)	V
AQC 302	Fish Biotechnology and Bioinformatics	2 (1+1)	VI
	Total Credits	**20 (12+8)**	
Aquatic Animal Health Management			
AAHM 101	Fundamental Microbiology	2 (1+1)	I
AAHM 201	Fish and Shellfish Diseases and Treatment	3 (2+1)	IV
AAHM 301	Pharmacology and Toxicology	3 (2+1)	V
AAHM 302	Fish Immunology	2 (1+1)	VI
AAHM 303	Therapeutics in Aquaculture	2 (1+1)	VI
	Total Credits	**12 (7+5)**	
Aquatic Environment Management			
AEM 101	Soil and Water Chemistry	3 (2+1)	I
AEM 102	Meteorology and Geography	2 (1+1)	I
AEM 103	Limnology	2 (1+1)	II
AEM 301	Marine Biology	2 (1+1)	V
AEM 302	Aquatic Ecology and Biodiversity	2 (1+1)	V
AEM 303	Coastal Zone Management	2 (1+1)	VI
	Total Credits	**13 (7+6)**	
Fish Engineering			
FE 201	Fishing Craft Technology	2 (1+1)	III
FE 202	Fishing and Gear Technology	3 (2+1)	IV
FE 301	Aquaculture Engineering	3 (2+1)	V
FE 302	Refrigeration and Equipment Engineering	2 (1+1)	VI
FE 303	Navigation and Seamanship	2 (1+1)	VI
	Total Credits	**12 (7+5)**	

Fisheries Extension, Economics and Statistics			
FEES 102	Fisheries Entrepreneurship Development and Business Management	3 (2+1)	II
FEES 103	Personality Development	2 (1+1)	II
FEES 201	Fisheries Extension	2 (1+1)	III
FEES 203	Agricultural (Fisheries) Marketing and Trade	3 (2+1)	IV
FEES 301	Fisheries Economics	3 (2+1)	V
FEES 302	Statistical Methods	3 (2+1)	VI
FEES 303	Fisheries Policy and Laws	1 (1+0)	VI
FEES 304	Fisheries Co-operative and Marketing	2 (1+1)	VI
	Total Credits	**19 (12+7)**	
Fish Processing Technology			
FPT 201	Fundamental of Biochemistry and Food Chemistry	3 (2+1)	III
FPT 202	Post-Harvest Handling and Preservation	2 (1+1)	III
FPT 205	Fish Products, By-Products, Value Addition and Waste Management	3 (2+1)	IV
FPT 301	Fish Freezing Technology	2 (1+1)	V
FPT 302	Fish Canning Technology and Packaging	2 (1+1)	V
FPT 303	Microbiology of Fish and Fisheries Products	2 (1+1)	VI
	Total Credits	**14 (8+6)**	
Fisheries Resource Management			
FRM 101	Taxonomy of Commercially Important Fish and Shellfish	3 (1+2)	I
FRM 102	Anatomy and Biology of Fish and Shellfish	3 (2+1)	II
FRM 103	Physiology of Fish and Shellfish	3 (2+1)	II
FRM 201	Inland Fisheries	2 (1+1)	III
FRM 202	Marine Fisheries	2 (1+1)	IV
FRM 301	Fish Population Dynamics and Stock Assessment	2 (1+1)	V
	Total Credits	**15 (8+7)**	

SKILL ENHANCEMENT COURSES*

Course No.	Course Title	Credits	Semester
Aquaculture			
AQC 102	Integrated Fish Farming	2 (0+2)	I
AQC 103	Non-conventional/Diversified Farming Practices (Pearl Farming/ Seaweed Farming/ Aquaponics/ Microalgae Production, etc.	2 (0+2)	I
AQC 105	Fish/Shellfish Breeding and Hatchery Operation	2 (0+2)	II

AQC 106	Fish/Shellfish Seed Rearing	2 (0+2)	II
AQC 203	Fish/Shellfish Grow-out Production Management	2 (0+2)	III
AQC 204	Breeding and Culture of Ornamental Fish	2 (0+2)	III
AQC 207	Fish Feed Production and Marketing	2 (0+2)	IV
AQC 208	Aquarium Making, Decoration and Management	2 (0+2)	IV
Aquatic Animal Health Management			
AAHM 202	Laboratory Techniques for Fish Pathogen Detection	2 (0+2)	IV
Aquatic Environment Management			
AEM 104	Analytical Techniques (Testing of Water, Soil, Feed etc.)	2 (0+2)	II
Fish Processing Technology			
FPT 203	Bio-chemical Analysis of Fish and Fisheries Products	2 (0+2)	III
FPT 204	Fish Handling, Transportation and Preservation	2 (0+2)	III
FPT 206	Preparation of Fish By-Products and Waste Utilization	2 (0+2)	IV
FPT 207	Preparation and Marketing of Value-Added Products	2 (0+2)	IV
Fish Engineering			
FE 203	Net Making and Mending	2 (0+2)	IV
Fisheries Extension, Economics and Statistics			
FEES 101	Start-up and Incubation in Fisheries	2 (0+2)	I
FEES 202	Data Analysis and Computation	2 (0+2)	III
FEES 204	Fish Market Survey and Value Chain Analysis	2 (0+2)	IV

ELECTIVE (MAJOR/MINOR) COURSES

Course No.	Course Title	Credits	Semester
Major Courses# (Students have the option to choose any Four Major Courses - 12 credits)			
AQC 401	Open-water Aquaculture	3 (2+1)	VII
AQC 402	Smart Aquaculture Production Systems	3 (2+1)	VII
AAHM 401	Fish and Shellfish Pathology	3 (2+1)	VII
AAHM 402	Disease Diagnostic Techniques	3 (2+1)	VII
AEM 401	Aquatic Pollution	3 (2+1)	VII
AEM 402	Fishery Oceanography	3 (2+1)	VII
AEM 403	Analytical Techniques in Aquatic Environmental Studies	3 (2+1)	VII
FPT 401	Quality Assurance of Fish and Fishery Products	3 (2+1)	VII

FRM 401	Sustainable Fisheries Management and Conservation	3 (2+1)	VII
Minor Courses## (Students have the option to choose any Four Minor Courses - 8 credits)			
AQC 403	Coldwater Aquaculture and Recreational Fisheries	2 (1+1)	VII
AEM 404	Aquatic Microbiology	2 (1+1)	VII
AEM 405	Climate Change and its Impact on Fisheries	2 (2+0)	VII
FE 401	GIS and Remote Sensing in Fisheries	2 (1+1)	VII
FE 402	Responsible and Sustainable Fishing Methods	2 (1+1)	VII
FEES 401	Marketing Intelligence and Business Analysis	2 (1+1)	VII
FEES 402	ICT in Fisheries	2 (1+1)	VII
FPT 402	Principles and Techniques of Seafood Analysis	2 (1+1)	VII
FPT 403	Trade Regulations, Certification and Documentation in Export of Fish and Fishery Products	2 (1+1)	VII

STUDENT READY (RURAL ENTREPRENEURSHIP AWARENESS DEVELOPMENT YOJANA) for B.F.SC., 4 YEAR PROGRAMME

Course No.	Course Title	Credits	Semester
FS 499	Student READY (In-plant/ Industrial Attachment, Rural Fisheries Work Experience (RFWE), Experiential Learning Programme (ELP), Project Work and Seminar) (To be taught by the Deptt. of Aquaculture, Aquatic Animal Health Management, Aquatic Environment Management, Fish Processing Technology and Fisheries Resource Management)	20 (0+20)	VIII
	In-plant/ Industrial Attachment (8 weeks)	5 (0+5)	
	Rural Fisheries Work Experience (RFWE) (8 weeks)	6 (0+6)	
	Experiential Learning Programme (ELP)	6 (0+6)	
	Project Work	2 (0+2)	
	Seminar	1 (0+1)	
	Total Credits	**20 (0+20)**	

NON-GRADIAL COURSES

Course No.	Course Title	Credits	Semester
FS 100	*Deeksharambh* (Induction cum Foundation course of 2 weeks)	2 (0+2)	I
FS 351	Educational Tour	2 (0+2)	V
TUT	Tutorial	1 (1+0)	I to VI
	Total Credits	**10 (6+4)**	

SUPPORTING COURSES: DEPARTMENT-WISE

COLLEGE OF AGRICULTURE

Course No.	Course Title	Credits	Semester
Agronomy			
AGRON 101 (MDC)	Farming Based Livelihood Systems	3 (2+1)	I
	Total Credits	**3 (2+1)**	
Soil Science			
SOILS 102 (VAC)	Environmental Studies and Disaster Management	3 (2+1)	II
	Total Credits	**3 (2+1)**	

COLLEGE OF BASIC SCIENCES AND HUMANITIES

Course No.	Course Title	Credits	Semester
Languages and Haryanvi Culture			
ENG 101 (AEC)	Communication Skills	2 (1+1)	I
	Total Credits	**2 (1+1)**	
Computer Section			
COMP 202 (VAC)	Agricultural Informatics and Artificial Intelligence	3 (2+1)	IV
	Total Credits	**3 (2+1)**	

DIRECTORATE OF STUDENTS' WELFARE

Course No.	Course Title	Credits	Semester
NCC I/ NSS I (AEC)	National Cadet Corps I/ National Service Scheme I	2 (0+2)	I
NCC II/ NSS II (AEC)	National Cadet Corps II/ National Service Scheme II	2 (0+2)	II
CCA 102	Co-curricular Activity	1 (0+1) NG	II
CCA 201 (AEC)	Physical Education, First Aid, Yoga Practices and Cultural Activities	2 (0+2)	III
NCC III/ NSS III	National Cadet Corps III/ National Service Scheme III	1 (0+1) NG	III
CCA 202	Co-curricular Activity	1 (0+1) NG	IV
NCC IV/ NSS IV	National Cadet Corps IV/ National Service Scheme IV	2 (0+2) NG	V
	Total Credits	**6 (0+6)**	

COURSE CONTENTS: DEPARTMENT-WISE

FOUNDATION COURSES

Course No.	Course Title	Credits	Semester
FS 100	*Deeksharambh* (Induction cum Foundation course of 2 weeks)	2 (0+2) NG	I
FS 351	Educational Tour	2 (0+2) NG	V
	Total Credits	**4 (0+4)**	

FS 100	DEEKSHARAMBH (Induction Cum Foundation Course of Two Weeks)	2 (0+2) NG	SEM I

Objectives

- Help for cultural integration of students from different backgrounds,
- Know about the operational framework of academic process in the University/College/Institute
- Instilling life and social skills,
- Social Awareness, Ethics and Values, Team Work, Leadership, Creativity, etc.
- Identify the traditional values and indigenous cultures along with diverse potentialities both in indigenous and developed scenario.
- Identify strength and weakness of the students in different core areas of the discipline.

Activities

i. Discussions on operational framework of academic process in the University, as well as interactions with academic and research managers of the University
ii. Interaction with alumni, business leaders, perspective employers, outstanding achievers in related fields, and people with inspiring life experiences
iii. Group activities to identify the strength and weakness of students (with expert advice for their improvement) as well as to create a platform for students to learn from each other's life experiences
iv. Activities to enhance cultural Integration of students from different backgrounds.
v. Field visits to related fields/ establishments
vi. Sessions on personality development (instilling life and social skills, social awareness, ethics and values, team work, leadership, etc.) and communication skills

FS 351	EDUCATIONAL TOUR	2 (0+2) NG	SEM V

To be conducted for 10-12 days after 5th Semester.
The students will visit industries/ institutions, preferably outside the state, so that, in addition to visiting the organizations/ industries (related to the profession), they will also be exposed to the geographical variability of different places/ states and the social and cultural differences existing in the country.
After the visit, the students will submit a report/ make a presentation.

AQUACULTURE

Course No.	Course Title	Credits	Semester
AQC 101	Freshwater Aquaculture	3 (2+1)	I
AQC 104	Fish and Shellfish Breeding and Hatchery Management	3 (2+1)	II
AQC 201	Coastal Aquaculture and Mariculture	3 (2+1)	III
AQC 202	Fish Nutrition and Feed Technology	3 (2+1)	III
AQC 205	Breeding and Culture of Ornamental Fish	2 (1+1)	IV
AQC 206	Live Food Organisms for Fish and Shellfish	2 (1+1)	IV
AQC 301	Fish Genetics and Breeding	2 (1+1)	V
AQC 302	Fish Biotechnology and Bioinformatics	2 (1+1)	VI
	Total Credits	**20 (12+8)**	
Skill Enhancement Courses			
AQC 102	Integrated Fish Farming	2 (0+2)	I
AQC 103	Non-conventional/Diversified Farming Practices (Pearl Farming/ Seaweed Farming/ Aquaponics/ Microalgae Production, etc.)	2 (0+2)	I
AQC 105	Fish/Shellfish Breeding and Hatchery Operation	2 (0+2)	II
AQC 106	Fish/Shellfish Seed Rearing	2 (0+2)	II
AQC 203	Fish/Shellfish Grow-out Production Management	2 (0+2)	III
AQC 204	Breeding and Culture of Ornamental Fish	2 (0+2)	III
AQC 207	Fish Feed Production and Marketing	2 (0+2)	IV
AQC 208	Aquarium Making, Decoration and Management	2 (0+2)	IV
	Total Credits	**16 (0+16)**	
Elective Courses			
AQC 401	Open-water Aquaculture	3 (2+1)	VII
AQC 402	Smart Aquaculture Production Systems	3 (2+1)	VII
AQC 403	Coldwater Aquaculture and Recreational Fisheries	2 (1+1)	VII
	Total Credits	**8 (5+3)**	
	Grand Total	**44 (17+27)**	

AQC 101	FRESHWATER AQUACULTURE	3 (2+1)	SEM I

Objectives

1. To gain knowledge and understand the recent advances in freshwater aquaculture under different culture systems
2. To impart the knowledge of the different types of aquaculture methods and commercially importable freshwater fish and shell-fish species

Theory

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

Practical

Preparation and management of nursery, rearing and grow-out ponds. Study on the 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 the economics of different culture practices. Estimation of livestock 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. Agarwal SC. 2008. A Handbook of Fish Farming. 2nd edn. Narendra Publ. House.
2. De Silva SS. (Ed.). 2001. Reservoir and Culture Based Fisheries: Biology and Management. ACAIR Proceedings.
3. FAO. 2007. Manual on Freshwater Prawn Farming.
4. Midlen and Redding TA. 1998. Environmental Management for Aquaculture. Kluwer.
5. New MB. 2000. Freshwater Prawn Farming. CRC Publ.
6. Pillay TVR and Kutty MN. 2005. Aquaculture- Principles and Practices. Blackwell.
7. Pillay TVR. 1990. Aquaculture: Principles and Practices. Fishing News Books, Cambridge University Press, Cambridge.
8. Rath RK. 2000. Freshwater Aquaculture. Scientific Publ.
9. Venugopal S. 2005. Aquaculture. Pointer Publ.
10. Welcomme RL. 2001. Inland Fisheries: Ecology and Management. Fishing News Book
11. ICAR. 2006. Handbook of Fisheries and Aquaculture.
12. Jhingran V.G. 1991. Fish and Fisheries of India, 3rd edn, Hindustan Publ.

AQC 104	FISH AND SHELLFISH BREEDING AND HATCHERY MANAGEMENT	3 (2+1)	SEM II

Objectives

1. To acquire knowledge and hands-on-training on the processes and practices of fish and shellfish breeding, hatchery management and quality seed production of different cultivable fish and shellfish species
2. To develop the professional skill on the production of fish and shellfish seeds and hatchery management

Theory

Freshwater and marine fish seed resources. Natural breeding of finfishes. Selection of riverine spawn collection sites, gears used and methods of collection. Spawn quality and quantity indices. Advantages and disadvantages of riverine seed collection. Sexual maturity and breeding season of various cultivable species. Development of gametes in male and female. Fish egg and embryonic development. 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. 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. Synthetic hormones used for induced breeding of carps. Different types of fish hatcheries-traditional, Chinese, glass jar and modern controlled hatcheries. Causes of mortalities of eggs and spawn and remedies. Spawn rearing techniques. Use of anesthetics in fish breeding and transport. Causes of mortalities of eggs and spawn and remedies. Spawn rearing techniques. Use of anesthetics in fish breeding and transport. Breeding techniques for Indian major carps, exotic carp, mahseer, trout, tilapias, catfishes, grey-mullets, milk fish, pearl spot, sea bass, sea horse, groupers, pacu, cobia, pompanos and indigenous fishes, etc. Off-season and multiple breeding of carps. Natural seed resources, site selection and collection methods.

Life cycle of important shellfish (*Penaeus monodon, P. indicus, Macrobrachiumrosenbergii, P.vannamei, Scylla serrata,* lobster, edible, oyster, pearl oyster, freshwater mussel, holothurians, horseshoe carb, Sepia, Loligo, cray fish etc.). Sexual maturity and breeding seasons of different species. Maturation stages of *Macrobrachiumrosenbergii*and Penaeus monodon and *P. vannamei*. Induced maturation in *Penaeus monodon, P. vannamei*and *P. indicus*by eye stalk ablation. Reproductive physiology. Reproductive hormones in crustaceans. Brood stock management of *Penaeus monodon* and *Macrobrachiumrosenbergii*. Breeding and hatchery management of *P. monodon* and *M. rosenbergii*. Breeding and hatchery management of crabs, lobster, mussels, edible and pearl oysters. Food and feeding of larval stages of important shellfishes. Health management in hatcheries.

Practical

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 anaesthetics, disinfectants and antibiotics in fish breeding. Water quality monitoring in fish hatcheries and nurseries. Breeding and larval rearing of common finfishes. Identification of brood stock and maturity stages of important crustaceans and molluscs. Observations on gonadal maturation of *Penaeus monodon* and *Macrobrachiumrosenbergii*. Breeding and larval rearing of *Macrobrachiumrosenbergii, Penaeus monodon,* and *P. vannamei*. Identification of larval stages of important crustaceans and molluscs. 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. FAO. 1992. Manual of Seed Production of Carps. FAO Publ.
2. Gupta SD, Mohapatra PC, Routray P, Sahoo SK, Verma DK, Sarangi N. 2008. Textbook of Breeding and Management of Carps. Narendra Publ. House
3. ICAR. 2006. Handbook of Fisheries and Aquaculture. ICAR.
4. Jhingran VG and Pullin RSV. 1985. Hatchery Manual for the Common, Chinese and Indian Major Carps. ICLARM, Philippines.
5. Landau M. 1992. Introduction to Aquaculture. John Wiley and Sons.
6. Pillay TVR and Kutty MN. 2005. Aquaculture- Principles and Practices. Blackwell.
7. Rath RK. 2000. Freshwater Aquaculture. Scientific Publ.
8. Thomas PC, Rath SC and Mohapatra KD. 2003. Breeding and Seed Production of Finfish and Shellfish. Daya Publ. House.
9. Kurian, C.V. and Sebastian, V.O., 1976. Prawns and prawn fisheries of India, Hindustan Pub. Corp., Delhi.
10. CMFRI 2009. Training Manual on Breeding and Larval Rearing of Marine Finfishes and Shellfishes.
11. Diwan AD, Joseph S and Ayyappan S. 2008. Physiology of Reproduction, Breeding and Culture of Tiger Shrimp. Narendra Publ. House
12. FAO 2007. Assessment of Freshwater Fish Seed Resources for Sustainable Aquaculture. FAO Fisheries Technical Paper No. 501.
13. Chakraborty C and Sadhu AK. 2000. Biology Hatchery and Culture Technology of Tiger Prawn and Giant Freshwater Prawn. Daya Publ. House.

AQC 201	COASTAL AQUACULTURE AND MARICULTURE	3 (2+1)	SEM III

Objectives

1. To gain knowledge on the culture of coastal and marine fish and shell-fish species
2. To acquire knowledge of coastal marine farming of fish and shellfish

Theory

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

Practical

Identification of important cultivable species. Collection and identification of commercially important seeds of fish and shellfish. 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. Appukuttan KK, Asokan PK, Mohamed KS, Subramaniam S and G Joseph GK. 2003. Manual on Mussel Farming. CMFRI Technical Bulletin 3.
2. Bardach EJ, Rhyther JH and Mc Larney WO. 1972. Aquaculture the Farming and Husbandry of Freshwater and Marine Organisms. John Wiley and Sons.
3. De Silva S.S. (Ed.)., 1998. Tropical Mariculture, Academic Press, 487p.
4. FAO. 2001. Planning and Management for Sustainable Coastal Aquaculture Development.
5. Ghosh, P.K. 2010. Brackishwater Aquaculture. Agrobios (India)
6. Halwar M., Soto D., and Arthur J.R., (Eds.). 2007, Cage Aquaculture: Regional reviews and Global Overview, FAO Fisheries Technical Paper No. 498, 241p.
7. ICAR. 2006. Handbook of Fisheries and Aquaculture. ICAR.
8. James PM. 1983. Handbook of Mariculture. Vol. I. Crustacean Aquaculture. CRC Press.
9. NFDB. 2018. Guidelines for sea cage farming in India.
10. Ottolenghi F, Silvestri C, Giordano P, Lovatelli A and New MB. 2004. Capture-based aquaculture: the fattening of eels, groupers, tunas and yellowtails. FAO Publ.
11. Pillay TVR and Kutty MN. 2005. Aquaculture: Principles and Practices. 2nd edn. Blackwell.

12. Pillay TVR. 1990. Aquaculture, Principles and Practices. Fishing News Books.
13. Sekar M, Ranjan R, Xavier B and Ghosh S. 2016. Training manual on cage culture of marine finfish. CMFRI Publ.
14. Syda Rao G, Imelda-Joseph, Philipose KK and Suresh Kumar M, 2013. Cage aquaculture in India. CMFRI Publ
15. Venugopal S. 2005. Aquaculture. Pointer Publ.

AQC 202	FISH NUTRITION AND FEED TECHNOLOGY	3 (2+1)	SEM III

Objectives

1. To understand the basic principles of fish nutrition and the role of different nutrients
2. To learn the process of feed formulation and preparation for fish and shellfish

Theory

Fundamentals of fish nutrition and growth in fish. Principal nutrients and nutritional requirements of cultivable fish and shellfish. Nutritional energetics: definition and forms of energy partitioning. Methods of feed formulation and manufacturing. 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. Feed storage: use of preservatives and antioxidants. Feed evaluation: feed conversion ratio, feed efficiency ratio, protein efficiency ratio, net protein utilization and biological value. Feeding devices and methods. Non-conventional feed ingredients and antinutritional factors. Digestive enzymes, feed digestibility. Factors affecting digestibility. Nutritional deficiency diseases.

Practical

Proximate composition analysis of feed ingredients and feeds. Preparation of artificial feeds using locally available feed ingredients. Formulation and preparation of moist feed by using locally available ingredients. Determination of sinking rate and stability of feeds. Effect of storage on feed quality. Estimation of the gross energy content of feed. Estimation of the digestible energy content of the feed. Equipment and machineries used in feed production. Visit to commercial feed plant.

Suggested Readings

1. ADCP (Aquaculture Development and Co-ordination Program). 1980. Fish Feed Technology, ADCP/REP/80/11. FAO., Rome.
2. De Silva, S. S. and Anderson, T. A. 1995. Fish Nutrition in Aquaculture, Chapman and Hall Aquaculture Series, London.
3. FAO training manual related to feed analysis.
4. Guillame, J., Kaushik, S., Berqot, P. and Metallier, R. 2001. Nutrition and Feeding of Fish and Crustaceans, Springer Praxis Publishing, Chichester, U.K.
5. Halver J. E. 1989. Fish Nutrition, Academic Press, San Diego, California.
6. Halver, J. E. and Hardy, R. W. 2002. Fish Nutrition. Academic Press, London.
7. Halver, J. E. and Tiews, K. T. 1979. Finfish Nutrition and Fish feed Technology Vol. I and II Heenemann, Berlin.

8. Hepher, B. 1988. Nutrition of Pond Fishes. Cambridge University Press, Cambridge.
9. Lovell, R. T. 1998. Nutrition and Feeding of Fishes. Kluwer Academic Publishers.
10. New, M.B. 1987. Feed and Feeding of Fish and Shrimp. A Manual on the Preparation and Preservation of Compound Feeds for Shrimp and Fish in Aquaculture. ADCP/REP/87/26 F.A.O. Rome.
11. Paulraj, R., 1993. Aquaculture Feed. CMFRI publication, 84 pp.

AQC 205	BREEDING AND CULTURE OF ORNAMENTAL FISH	2 (1+1)	SEM IV

Objectives

1. To gain knowledge on ornamental fish production technologies and aquarium building
2. To produce ornamental fish for marketing

Theory

World trade of ornamental fish and export potential. Different varieties of exotic and indigenous fishes. Principles of a balanced aquarium. Fabrication, setting up and maintenance of freshwater and marine aquarium. Water quality management. Water filtration system-biological, mechanical and chemical. Types of filters. Aquarium plants and their propagation methods. Lighting and aeration. Aquarium accessories and decorative. Aquarium fish feeds. Dry, wet and live feeds. Breeding and rearing of ornamental fishes. Broodstock management. Application of genetics and biotechnology for producing quality strains. Management practices of ornamental fish farms. Common diseases and their control. Conditioning, packing, transport, and quarantine methods. Trade regulations and wildlife act in relation to ornamental fishes.

Practical

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. Ahilan, B., Felix, N., and Santhanam, R. 2008. Textbook of Aquariculture. Daya Publishing House, Delhi.
2. Axelrod HR and Sweenen ME. 1992. The Fascination of Breeding Aquarium Fishes. TFH Publ.
3. Axelrod HR and Vorderwinkler W. 1978. Encyclopaedia of Tropical Fishes. TFH Publ.
4. Axelrod HR. 1967. Breeding Aquarium Fishes. TFH Publ.
5. Boyd CE. 1979. Water Quality in Warm Water Fish Ponds. Auburn
6. Crow R. and Keeley D. 1992. A Practical Guide to Tropical Aquarium Fish. Tiger Book Int., London.

7. Mills D. 1981. Aquarium Fishes. Kingfisher Books.
8. Sanford G and Crow R. 1991. The Manual of Tank Busters. Salamander Books.
9. Saxena A. (Ed.). 2003. Aquarium Management. Daya Publ.10. Spotte S. 1979. Fish and Invertebrate Culture. John Wiley and Sons.
10. Swain S.K., Sarangi, N. and Ayyappan, S. 2010. Ornamental Fish Farming. ICAR.
11. Thabrow De WV. 1981. Popular Aquarium Plants. Thornbill Press
12. Thomas PC, Rath SC and Mohapatra KD. 2003. Breeding and Seed Production of Finfish and Shellfish. Daya Publ. House.

AQC 206	LIVE FOOD ORGANISMS FOR FISH AND SHELLFISH	2 (1+1)	SEM IV

Objectives

1. To learn the nutritional requirements of fish and shell-fish larvae
2. Techniques the culture of live food organisms from fish and shell-fish larvae

Theory

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

Practical

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. Proximate composition analysis of live feed organisms. Decapsulation and hatching method of brine shrimp cyst.

Suggested Readings

1. CIFE. 1993. Training Manual on Culture of Live Food Organisms for AQUA Hatcheries. Central Institute of Fisheries Education, Versova, Mumbai.
2. Gopinathan CP. 1993. Handbook on Aqua Farming - Live Feed. MPEDA Publication
3. Hagiwara A, Snell TW, Lubzens E and Tamaru CS. 1997. Live Food in Aquaculture. Proceedings of the Live Food and Marine Larviculture Symposium. Kluwer.
4. Joan Holt G. 2011. Larval fish nutrition. Wiley Blackwell Publ.
5. Lavens P and Sorgeloos P. (eds.). 1996. Manual on the production and use of live food for aquaculture. FAO Fisheries Technical Paper. No. 361. Rome, FAO, 295pp.
6. Lee CS., O'Bryen, PJ, Marcus NH. 2005. Copepods in aquaculture. Blackwell Publishing.
7. MamtaRawat, SumitDookia. 2012. Biodiversity of Aquatic Resources. Day.
8. MPEDA. 1993. Handbook on Aqua Farming - Live Feed. Micro Algal Culture. MPEDA Publication.

9. Muthu MS. 1983. Culture of Live Feed Organisms. Tech. Paper 14. Summer Institute in Hatchery Production of Prawns Seeds. CMFRI, Cochin.
10. Sorgeloos P and Pandian KS. 1984. Culture of Live Food Organisms with Special Reference to Artemia Culture. CMFRI Spl. Publ. No. 15.

AQC 301	FISH GENETICS AND BREEDING	2 (1+1)	SEM V

Objectives

1. To understand the basic principles of genetics and breeding and their application to fisheries
2. To improve the quality and quantity of fish and shell-fish species

Theory

Principles of genetics and breeding. Gene and chromosome as basis of inheritance. Mendel's law of inheritance – complete and incomplete dominance, monohybrid and dihybrid ratios. Gene interactions – dominant and recessive epistasis. Pleiotropism. Lethal genes. Mutation. 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. Chromosome manipulation techniques - androgenesis, gynogenesis and polyploidy and identification of ploidy. Sex determination. Cross breeding (hybridization) – types of crossbreeding, heterosis and design of cross-breeding programs, hybridization in different fishes. Quantitative genetics – quantitative traits, polygenic traits, heritability. History and present status of selective breeding programs in aquaculture. Selection methods and mating designs. Design for selective breeding. Inbreeding and its consequences. Domestication methods. Seed certification and quarantine procedures. Cryopreservation of gametes.

Practical

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. Estimation of inbreeding coefficient. Preparation of Selection index for the selective breeding program. 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. Study of risk factors in cryopreservation technique.

Suggested Readings

1. Ayyappan S. 2004. Fisheries Biotechnology. Narendra Publ. House.
2. GjedremTrygve et al. 2005. Selection and Breeding Programs in Aquaculture. Springer.
3. Kirpichnikov VS. 1981. Genetic Basis of Fish Selection. Springer-Verlag.
4. Lakra WS, Abidi SAH, Mukherjee SC and Lutz CG. 2003. Practical Genetics for Aquaculture. Wiley-Blackwell.
5. Lutz CG. 2003. Practical Genetics for Aquaculture. Wiley-Blackwell.

6. Lynch M and Walsh B. 1997. Genetics and Analysis of Quantitative Traits. Sinauer, Sunderland.
7. Nagabhushanam R, Diwan AD, Zahurnec BJ and Sarojini R. 2004. Biotechnology of Aquatic Animals. Science Publ.
8. Nair PR. 2008. Biotechnology and Genetics in Fisheries and Aquaculture. Dominant Publ.
9. Purdom CE. 1993. Genetics and Fish Breeding. Chapman and Hall.
10. Snustad DP and Simmons MJ. 1999. Principles of Genetics. 2nd edn. John Wiley and Sons.
11. Stansfield WD. 1991. Theory and Problems of Genetics. McGraw-Hill.
12. Tave D. 1993. Genetics for Fish Hatchery Managers. 2nd edn. Chapman and Hall.

AQC 302	FISH BIOTECHNOLOGY AND BIOINFORMATICS	2 (1+1)	SEM VI

Objectives

- To understand the basic principles of fish biotechnology and bioinformatics and its applications to fisheries

Theory

Introduction to Biotechnology –scope and importance in fisheries/ aquaculture. Structural organization of prokaryotic and eukaryotic cell. Nucleic acids -structure, function and types, Concepts of gene and genetic code, transcription and translation, mutations and their implications. Post-transcriptional modification and RNA processing. Gene regulation and expression in prokaryotes and eukaryotes. DNA sequencing, Operons. Genetic engineering: Restriction enzymes, Gene isolation, Cloning vectors, Probes. Recombinant DNA technology – vaccines. Transgenic fish and Gene transfer technology, 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. 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.

Practical

Study of structure of prokaryote and Eukaryote Cells. Isolation of DNA and RNA. PCR amplification. Gel Electrophoresis. Study on Model of protein Synthesis. Study of models of DNA Technology. Cell Culture. Isolation of Nucleic Acids. Restriction enzymes. ELISA. DNA sequence analysis and comparison. Study of data search engines. Study of different databases.

Suggested Readings

1. Diwan AD. 2018. Biotechnology of penaeid shrimps. Narendra Publ.

2. Felix S and Ninawe AS. 2014. Aquaculture Biotechnology. Daya Publishing House.
3. Fletcher GL, Rise ML. 2012. Aquaculture Biotechnology. Wiley Blackwell.
4. Gautam NC. 2007. Comprehensive Biotechnology- Vol. 4 Aquaculture Biotechnology. Shree Publishers and Distributors
5. Green and Sambrook. 2012. Molecular cloning A laboratory manual. Fourth Edition. Cold Spring Harbor Laboratory Press Publ.
6. Greglutz C. 2001. Practical genetics for aquaculture. Wiley Blackwell Publ.
7. Klug, W.S., Cummings, M.R., Spencer, C.A. and Palladino, M.A.2012. Concepts of Genetics. Tenth Edition. Pearson Publ.
8. Lakra WS, Abidi, SAH, Mukherjee, SC, and Ayyappan S. 2014. Fisheries biotechnology.
9. Montet D and Ray RC. 2009. Aquaculture Microbiology and Biotechnology. Vol. 1. Science Publishers.
10. Nair PR. 2008. Biotechnology and Genetics in Fisheries and Aquaculture. Dominant Publ.
11. Pandian TJ, Strussmann CA and Marian MP. 2005. Fish Genetics and Aquaculture Biotechnology. Science Publ.
12. Primrose SB. 1989. Modern Biotechnology. Blackwell.
13. Reddy PVGK, Ayyappan S, Thampy DM and Krishna G. 2005. Fish Genetics and Biotechnology. ICAR.
14. Richard Reece, 2017. Analysis of genes and genomes.
15. Se-Kwon Kim, 2017. Springer handbook of marine biotechnology.
16. Sunita R. 2015. Fish Biotechnology. Random Publications.

AQC 102	INTEGRATED FISH FARMING	2 (0+2)	SEM I

Objectives

1. To optimize resource use and increase farm income through the integration of crop, fish, and livestock systems
2. To evaluate the design, management, and economic viability of various integrated farming models for sustainable aquaculture development

Practical

Introduction to Integrated Farming Systems (IFS): fish–crop–livestock synergy, benefits of natural fertilization and resource recycling. Site selection & system types: paddy–fish, pond-based fish + livestock + vegetable integration (e.g. rice-fish, livestock-pond embankments). Assess soil and water quality for fish farming. Integrated farming system with crop, fish, and livestock production to improve resource use and farm income. A key aspect is estimating how many livestock are needed per unit in aquaculture systems, as animal waste serves as a natural fertilizer for fish ponds. In paddy–fish systems, proper field design is crucial maintaining water depth, constructing bunds, and creating refuge trenches for fish ensures both rice and fish thrive without conflict. Calculating and applying appropriate stocking density. For fish and shrimp farming, pond size, depth, water management, and species selection must be planned to suit local conditions. Building livestock shelters on pond embankments saves space and supports easy waste management.

AQC 103	NON-CONVENTIONAL/ DIVERSIFIED FARMING PRACTICES (PEARL FARMING/ SEAWEED FARMING/ AQUAPONICS/ MICROALGAE PRODUCTION, ETC.)	2 (0+2)	SEM I

Objectives

1. To help students learn hands-on skills in modern farming methods like pearl farming, seaweed growing, aquaponics, and microalgae farming
2. To encourage eco-friendly farming and business ideas by teaching product development, marketing, and giving real-life experience through field visit

Practical

Introduction to non-conventional farming – overview, importance, sustainability benefits pearl farming – site selection, oyster breeding, implantation, harvesting techniques, seaweed farming – cultivation methods (raft, net), species selection, harvesting, and uses, aquaponics – design, water chemistry, plant-fish integration, nutrient cycling, microalgae production – strain selection, photo bioreactor setup, biomass harvesting. value addition & marketing – product development and market trends.

AQC 105	FISH/SHELLFISH BREEDING AND HATCHERY OPERATION	2 (0+2)	SEM II

Objectives

1. To provide hands-on experience in the selection, management, and breeding of fish and shellfish10120, including techniques like hormonal treatments and egg collection
2. To teach students how to manage hatchery operations, monitor water quality, prevent diseases, and ensure optimal conditions for larval and juvenile fish development

Practical

Study of aquaculture breeding systems, hatchery management, and species-specific breeding methods, techniques for selecting and managing brood stock for optimal reproduction, conditioning, and maintenance of fish and shellfish species, hands-on practice in inducing breeding through hormonal treatments (e.g., pituitary gland extraction and pg injection), and understanding reproductive cycles, techniques for egg collection, incubation, and larval rearing; understanding the different developmental stages from fertilization to early juvenile, monitoring and controlling essential water parameters (oxygen levels, pH, salinity, temperature) for optimal breeding and larval survival, identifying common hatchery diseases, applying disease prevention measures, and using antibiotics, disinfectants, and vaccines in hatchery operations, a visit to a commercial hatchery to observe and practice all aspects of hatchery operations, including egg collection, breeding, and juvenile rearing.

AQC 106	FISH/SHELLFISH SEED REARING	2 (0+2)	SEM II

Objectives

1. To learn the basics of fish and shellfish seed rearing, including collecting, handling, and transporting them while maintaining safe water quality
2. To understand how to manage nursery tanks and feed

Practical

Study of Fish/Shellfish seed rearing methods, and stages of seed development, techniques for collecting, handling, and transporting fish and shellfish seed safely, monitoring and maintaining optimal water quality for seed survival, including oxygen levels, pH, temperature, and salinity. rearing fish and shellfish larvae, feeding methods, and nursery management, practices for managing nursery tanks, density, and grading, identifying and managing diseases in seeds and juveniles, use of vaccines, disinfectants, and treatments, grading, sorting, and preparing seeds for stocking in grow-out systems.

AQC 203	FISH/SHELLFISH GROW-OUT PRODUCTION MANAGEMENT	2 (0+2)	SEM III

Objectives

1. To learn about the grow-out phase in aquaculture, including production systems, site selection, and keeping water quality ideal for fish and shellfish growth
2. To understand how to manage feeding, fish health, growth, and the processes for harvesting, grading, and preparing fish and shellfish for the market

Practical

Overview of the grow-out phase in aquaculture, its importance, and the different types of fish and shellfish production systems (ponds, cages, tanks), study on choosing appropriate sites for grow-out operations, setting up ponds, cages, and tanks, and understanding the environmental and logistical considerations. hands-on training in monitoring and maintaining water quality parameters such as temperature, pH, salinity, dissolved oxygen, and ammonia levels for optimal growth, techniques for developing feeding schedules, selecting appropriate feed types, and ensuring balanced nutrition for different fish and shellfish species, identifying common diseases, implementing biosecurity measures, and using treatments such as antibiotics, vaccines, and other health management protocols. regularly assessing the growth rate of fish and shellfish, maintaining accurate records, and evaluating feed conversion ratios and growth performance, techniques for harvesting, grading, and preparing fish/shellfish for market, along with post-harvest handling, storage, and transportation.

AQC 204	BREEDING AND CULTURE OF ORNAMENTAL FISH	2 (0+2)	SEM III

Objective

1. To learn about fish nutrition, how to make balanced diets and quality feed, and understand how fish feed is marketed and distributed

Practical

Study of importance of nutrition in aquaculture, types of fish feed, and market demand for fish feed, study of common raw materials used in fish feed (protein, fat, vitamins, minerals), and how to formulate balanced diets based on species' nutritional needs, hands-on training in grinding, mixing, pelletizing, and drying feed, understanding different feed production methods, including extruder and pellet mill operation, techniques for testing feed quality (protein content, digestibility, moisture levels), and ensuring consistent quality in production, methods for proper storage of fish feed to prevent spoilage and maintain nutritional quality, including packaging and labeling, market analysis, identifying target customers, pricing strategies, branding, and distribution channels for fish feed, visit to a commercial fish feed production facility to observe large-scale feed manufacturing and marketing processes.

AQC 207	FISH FEED PRODUCTION AND MARKETING	2 (0+2)	SEM IV

Objectives

1. To understand ornamental fish farming, including selecting healthy brood stock, breeding methods, and managing optimal conditions for successful breeding and market potential

Practical

Study ornamental fish farming, types of ornamental fish, breeding significance, and market potential, methods for selecting healthy brood stock, maintaining optimal water conditions, and conditioning fish for breeding, practical experience in induced breeding, natural spawning, and managing breeding pairs, hormonal treatment methods (e.g., pituitary gland extract) for species with breeding challenges.

AQC 208	AQUARIUM MAKING, DECORATION AND MANAGEMENT	2 (0+2)	SEM IV

Objectives

1. To learn how to set up and manage aquariums, including designing, selecting equipment, creating aquascapes, and maintaining water quality
2. Students will also learn about hands-on experience in caring for fish

Practical

Study of different types of aquariums (freshwater, marine, and planted), basic principles of aquarium setup, and the importance of aquarium management, practical experience in designing aquariums, choosing the right size, selecting equipment

(filters, heaters, lighting), and setting up filtration systems. study of plants, rocks, and other decorative elements and techniques for creating aesthetic aquascapes, including selecting and arranging plants, rocks, driftwood, and other décor items to mimic natural environments, training in monitoring and maintaining key water parameters to ensure a healthy environment for aquatic life, learning about compatible fish species, feeding practices, and disease management, practical sessions on cleaning, maintenance schedules, and troubleshooting common aquarium problems like algae growth, water clarity, and fish health, visit to an aquarium shop or aquatic facility to observe professional setups, decoration, and management techniques.

AQC 401	OPEN-WATER AQUACULTURE	3 (2+1)	SEM VII

Objective

- To learn about the open water resources and their enhancement of aquaculture production

Theory

Overview of global scenario of aquaculture in open waters, open water resources in India, Present status, Utilization, Prospects of production augmentation, Utilization of open water bodies for aquaculture to enhance production. Salient features of open water limnology and their significance to fisheries development; management of small, medium and large water bodies; present status and future prospects in open water fish production. Recent advances in open water fisheries management; conservation measures in open water fisheries. Fish stocking in open water. Cage Culture: Role of cage in enhancement of fish production in reservoirs, estuaries, open sea and open water bodies; History of cage culture, advantages of cage culture; Cages for sea, estuaries, reservoirs, lakes and canals; Selection of suitable site of cage culture; cage materials, designs, shape, size and fabrication; cage frames and supporting system; Different designs of open sea farming structures-construction of cages-bioengineering problems and solutions, Species selection for open water aquaculture, Rearing of fingerlings, advanced fingerlings and table size fish in open water bodies; Constraints in cage culture; Economics of cage culture; Integration of cage culture with other farming systems. Pen Culture: 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 pens; constraints in pen culture; economics of pen culture. Practices: Ranching in open waters, species quality and quantity, Natural feed enhancement, Supplementary feeding in cages and pens, Stock assessment, Harvesting and conflicts with irrigation, Drinking water and hydroelectric projects on open water farming. Environmental impact of Open water Aquaculture: Salinity intrusion, Effluent discharge, Eutrophication, Chemical residues including antibiotics and hormones, Destruction of natural habitat including paddy field and mangroves. Social issues and conflicts with other users on resources.

Practical

Preparation of charts on the present situation of open water fisheries productivity. Different types of cage materials, fabrication of cages and pens and their installation.

Determination of stocking density in cages and pens. Feeding in cages and pens. Stock assessment in cages and pens. Environmental impact of cages and pens. Case studies on cage and pen culture. Field visit to cage and pen culture site to acquaint with construction details and operation.

Suggested Readings

1. Beveridge M. 2008. Cage Aquaculture. Oxford Publ.
2. Beveridge MCM. (Ed.). 2004. Cage Aquaculture, 3rd edn. Blackwell Publishing.
3. Burnell G and Allan G. 2009. New Technologies in Aquaculture. 1st Edition. Woodhead Publishing House.
4. Chiu Liao I and Kwei Lin C. 2000. Cage aquaculture in Asia: Proceedings of the First International Symposium on Cage Aquaculture in Asia, AFS and WAS Publ.
5. FAO. 2018. The State of World Fisheries and Aquaculture -Meeting the Sustainable development goals. Rome.
6. NFDB. 2018. Guidelines for Sea Cage Farming in India.
7. Syda Rao G, Imelda-Joseph, Philipose KK and Suresh Kumar M. 2013. Cage Aquaculture in India. CMFRI Publ.

AQC 402	SMART AQUACULTURE PRODUCTION SYSTEMS	3 (2+1)	SEM VII

Objective

To learn the advanced aquaculture production system research for different species globally

Theory

Introduction: An overview of global aquaculture production, demand- consumption scenario and emerging trends, Present status, Constraints and future prospects in India and the world, Aquaculture practices indifferent parts of the world, Enhancing carrying capacity in culture systems. Biofloc technology: Principles of biofloc, Different carbon sources, Design of aeration system and biofloc reactor. Carrying capacity, C: N ratio, harvesting of biofloc, Biofloc quality and quantity, Biofloc as feed ingredient, Stocking of fish and shellfish species. Bioremediation in wastewater aquaculture. Minimal water exchange aquaculture systems: Principles of closed system farming, RAS, Components, design of mechanical and biological filters for the water reuse system, Sludge removal, disposal of wastes and control of pollution to the environment, Design of RAS, biofiltration and nitrifiers, Suitable cultivable species for indoor culture systems, polyhouses. Aquaponics: Principles, Components and design of different aquaponics systems, Components in aquaponics, ratio of fish and plants, Water quality and system maintenance, Resource utilization, Nutrient recycling and zero discharge of nutrients. Running water systems: Flow-through system, Raceways (IPR), IMTA, Partitioned Aquaculture Systems (PAS), Aqua mimicry systems. Other farming methods: Cluster farming, Organic farming, Satellite farming, co-operative farming and conservation aquaculture, Network of production and marketing aspects, Economics of super intensive farming systems, Advantages and disadvantages.

Practical

Design, fabrication and performance evaluation of biofloc systems; Different equipment in closed grow-out system; Aerators, Biofilters, RAS, Raceways, IMTA, PAS and aquaponics systems; Plankton and microbial analysis of biofloc. Studies on different C: N ratio; Nutrient analysis in aquaponics; Visit to hatcheries with super-intensive models. Identification and understanding the network of the systems; Market analysis for the produces; Analysis of economic advantages, case studies.

Suggested Readings

1. Avnimelech Y. 2015. Biofloc Technology- a Practical Guidebook. 3rd edn. World Aquaculture Society
2. Chakrabarti NM. 2014. Biology, Culture and Production of Indian Major Carps.
3. Felix S. 2008. Biosecured Aquaculture- Principle and Prototype. Agrobios (India)
4. Soderberg RW. 1995. Flowing Water Fish Culture. Lewis Publishers.
5. Tidwell JH. (Ed.). 2012. Aquaculture Production Systems. Wiley-Blackwell.

AQC 403	COLDWATER AQUACULTURE AND RECREATIONAL FISHERIES	2 (1+1)	SEM VII

Objectives

1. To learn about the breeding and culture of different cold-water fishes and their importance as sport fisheries or recreation fisheries
2. Eco-tourism and recreational aquaculture

Theory

Introduction: Status of coldwater fisheries in World with special reference to India, Biology, breeding and culture of trouts (*Oncorhynchus mykiss, Salmo truttafario, Schizothoraichthysesocinus, S. longipinnis, S. niger, Schizothoraxrichadsonii*), mahseer*(Tor putitora, Tor tor, Tor khudree)*, common carp *(Cypinuscarpiocummuinis, Cyprinuscarpiospecularis)*. Specific environmental parameters pertaining to cold water fish culture and metabolic interaction, Feeds suitable for cold water aquaculture. Culture of cold-water fishes: Construction and management of cold-water fish farms, Effect of exotic fish introduction on indigenous fish fauna, Polyculture of exotic carp in mid hill region based on three Chinese carps, post-harvest and harvest issues in trout with regards to cold water species, Special factors for consideration in cold water fish seed production and nursery rearing. Introduction to sport fisheries: Sports fishes and their life history, Equipment for sports fishing, fishing methods, area suitable for sports fishing, etc. Management and conservation of sports fisheries through aquaculture, Sport fisheries and tourism, recreational aquaculture. Issues and Desired Interventions: Potential and Innovative Strategies for the Development of coldwater Aquaculture in India- problems encountered in fisheries development of rivers supporting coldwater fisheries.

Practical

Identification of coldwater fish species. Primary and secondary sexual characters in cold water fishes. Different breeding methods for cold water fishes. Identification of larval stages of trout and mahseer. Preparation of hatchery layout for coldwater

fishes. Studies on different types of sports fishing equipment. Visit to coldwater fish hatcheries and farms.

Suggested Readings

1. Boghen, A.D. 1989. Cold-water aquaculture in Atlantic Canada. InstitutCanadien de recherche sur le development regional, Atlantic Coast, Canada
2. ICAR. 2006. Handbook of Fisheries and Aquaculture.
3. Jhingran VG and Sehgal KL. 1978. Cold Water Fisheries of India. J. Inland. Fish. Soc. India. Sp. Publ.
4. Mahanta, P.C. and Sarma, D. 2010. Coldwater Fisheries Management. ICAR
5. Singh, H.R. and Lakra, W.S. 2008. Coldwater Aquaculture and Fisheries. Narendra Publishing House.
6. Singh AK, Sarma D, Akhtar, MS and Baruah D. 2017. Souvenir – National seminar on strategies, innovations and sustainable management for enhancing cold water fisheries and aquaculture. ICAR-DCFR, Bhimtal.

AQUATIC ANIMAL HEALTH MANAGEMENT

Course No.	Course Title	Credits	Semester
Core Courses			
AAHM 101	Fundamental Microbiology	2 (1+1)	I
AAHM 201	Fish and Shellfish Diseases and Treatment	3 (2+1)	IV
AAHM 301	Pharmacology and Toxicology	3 (2+1)	V
AAHM 302	Fish Immunology	2 (1+1)	VI
AAHM 303	Therapeutics in Aquaculture	2 (1+1)	VI
	Total Credits	**12 (7+5)**	
Skill Enhancement Course			
AAHM 202	Laboratory Techniques for Fish Pathogen Detection	2 (0+2)	IV
	Total Credits	**2 (0+2)**	
Elective Courses			
AAHM 401	Fish and Shellfish Pathology	3 (2+1)	VII
AAHM 402	Disease Diagnostic Techniques	3 (2+1)	VII
	Total Credits	**6 (4+2)**	
	Grand Total	**20(11+9)**	

AAHM 101	FUNDAMENTAL MICROBIOLOGY	2 (1+1)	SEM I

Objectives

1. To create a basic understanding on microbiology and its importance in the aquatic environment
2. To develop skills in the identification of microbes, culture of microbes, and diagnosis of microbial pathogens in aquatic organisms

Theory

Milestones in microbiology. Contributions of Leeuwenhoek, Louis Pasteur, Robert Koch, Alexander Flemming, Joseph Lister, Winogrdasky. Microscopy- Principle and construction of brightfield, dark field, phase contrast, stereo, SEM and TEM. 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. 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. Bacterial metabolism: Nutrient requirements, nutritional types, bacterial photosynthesis and their ecological significance. Microbial growth: Growth phases, measurement of cell growth, factors affecting growth- influence of physicochemical

factors - pH, temperature, moisture, light, osmotic pressure, fermentation - types and significance. Microbial genetics- general principles, genetic recombination, transformation, transduction and conjugation. Plasmids- types and their importance. Mutation –types and significance. Microbial ecology: Introduction and types of interaction, extremophiles and their significance.

Aquatic Microbiology: Introduction and scope of aquatic microbiology, aquatic environment as habitat for microorganisms - bacteria, cyanobacteria, fungi, algae, parasites and viruses. Distribution of microorganisms and their biomass in rivers, lakes, sea and sediment. Influence of physical, chemical and biological factors on aquatic microbes. Microbial biofilms. Role of microbes in the production and breakdown of organic matter. Role of microbes in sedimentation and mineralization process. 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. Economic significance of aquatic microbes.

Practical

Handling of microscopes, Wet mount, smear and hanging drop preparations Micrometry. Determination of size of microorganisms (ocular, stage micrometers). Tools and techniques in sterilization methods: Filtration, 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

1. Chakraborthy P. 1995. A Text Book of Microbiology. New Central Book Agency.
2. Criusted J. 1986. Methods in Microbiology. Academic Press.
3. Harry WSJR, Paul JV and John JL. 2000. Microbes in Action. Freeman andCo.
4. James M. 1978. Modern Food Microbiology. 2nd edn. D. Van Nostrand Co.
5. Michael J, Pelizar JR and Chan ECS. 1998. Microbiology. Tata McGraw Hill.
6. Paul JH. 2001. Marine Microbiology - Methods in Microbiology. Vol. XXX. Academic Press.
7. Samuel CP and Dunn CG. 1959. Industrial Microbiology. McGraw Hill.
8. Silliker JH, Elliof RP, Baired AC and Boyan FL. 1980. Microbial Ecology of Foods. Vol. II (ICMSF). Academic Press.
9. William CF and Westhoff DC. 2000. Food Microbiology. Tata Mc Graw Hill.
10. Khuntia B. K. 2021. Basic Microbiology- A Illustrated Laboratory Manual. Daya Publ.

AAHM 201	FISH AND SHELLFISH DISEASES AND TREATMENT	3 (2+1)	SEM IV

Objectives

1. To understand the recent advances in diseases of fish and shell-fish and their remedial measures
2. Fish and Shellfish disease diagnosis and treatment

Theory

General characteristics, life cycle, diagnosis of pathogens. Prevention and treatment of parasitic, bacterial, fungal and viral diseases of finfish and shellfish. OIE listed diseases. Disease surveillance and reporting. Quarantine and health certification in aquaculture. Health management strategies in Aquaculture: Bioremediators, Biocontrol agents, Probiotics, Immunomodulators, Concepts of vaccination. Shrimp toilet. Management measures for the host. Specific pathogen-free (SPF), Specific pathogen-resistant (SPR) and Specific pathogen-tolerant (SPT). Developing management practices and biosecurity principles: Health maintenance, better management practices (BMP), Good aquaculture practices (GAP), Hazard analysis and Critical control point (HACCP) and Biosecurity principles in aquaculture.

Disease control through environmental management: Importance of Biofilm and Bio-floc. Periphyton in aquatic health management. Zoonotic diseases. Principles of disease diagnosis: Conventional, molecular and antibody-based diagnostic methods. Rapid diagnostic methods.

Practical

General procedure for disease diagnosis. Methods of fish and shell-fish sampling for disease diagnosis. Taxonomy, lifecycle and identification of fish and shell-fish 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 and Challenge tests; Purification of virus. Stress-related study of fish and shellfish. Prevention and treatment of parasitic, bacterial, fungal and viral diseases of finfish and shellfish.

Suggested Readings

1. Alan C. 2005. Molecular Virology. Academic Press 315 p.
2. Austin B and Austin A. 2007. Bacterial Fish Pathogens. Springer Publishers, U.K.
3. Bullock LG. 2014. Diseases of Fishes. NPH, Delhi
4. Cox FEG. 2005. Parasitology. Hodder Arnold. U.S.A.
5. Crosa JH. 1983. Bacterial and Viral Diseases of Fish. Washington Sea Grant Publication, Seattle.
6. Gupta N. 2014. Modern Parasitology. Narendra Publishing House, Delhi
7. Hadwin G. 2017. Diseases of Fishes. Bacterial Diseases of Fishes and Identification of Fish Pathogenic Bacteria. Random Pub., New Delhi.
8. Iglewski HB and Clark VL. 1009. Molecular Basis of Bacterial Pathogenicity. Academic Press.

9. Inglis V. 1993. Bacterial Diseases of Fish. Blackwell Scientific Publications, London.
10. Roberts RJ. 2012. Fish Pathology. 4th Ed. W.B. Saunders.

AAHM 301	PHARMACOLOGY AND TOXICOLOGY	3 (2+1)	SEM V

Objectives

1. To understand the application and impact of aquaculture drugs and chemicals in fisheries
2. To impart knowledge on the toxicity of drugs and chemicals on aquaculture and fisheries

Theory

Introduction to Pharmacology: History, Importance, Terms and Definitions, Drug development, Screening and Nomenclature, Scope of pharmacology in fishes. Route of Administration and Method of application to fish. Source of Drugs. Pharmacotherapeutic classification of drugs. Pharmacokinetics: Biological membrane, absorption, distribution, biotransformation, and excretion of drugs. Factors influencing drug metabolism. 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. Factors modifying drug action, Adverse drug effects, drug interaction and Bioassay of drugs. Salient features in drug acting on digestive system, nervous system and cardiovascular system. Drugs used in fish transportation. Recent advances in Pharmacology, biostatistics in experimental Pharmacology, Pharmaceutical industry.

General Toxicology: Definitions, Branches of Toxicology, Historical developments, Classification and types of poison. Toxicity testing - Chronocity factor, Untoward effects, Common causes, Diagnosis of poisoning, Factors modifying toxicity, Toxicokinetic, Toxicodynamic, General approaches to diagnosis and treatment of poisoning.

Systemic Toxicology: Toxicity caused by metal and non-metals, Phytotoxins- Toxic principles of various alkaloids and toxic plants, Drug toxicity and toxicity caused by agrochemicals. Mycotoxins, Bacterial toxins. Collections and dispatch of specimens in Toxicological cases. Toxicity of drugs in Aquaculture: Maximum Residual Limits (MRL) of various drugs and chemicals in fish. Metabolism of toxic substances by aquatic organisms.

Practical

Metrology, Prescription Writing, Preparation of drug solution, Source and chemical nature of drugs. Incompatibility, Pharmaceutical technology, Bioassay of drugs, Animal models in Pharmacological experiments, Methods of application of drugs in fish.

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 (NH_4^+), Chloride (Cl^-), Phosphate (PO_4^{2-})

Sulphate (SO_4^{2-}), Fluoride (Fl^-). Qualitative detection of Nitrite and Nitrate. Detection of hydrocyanic acid. Detection and Estimation of Mycotoxins. Test for detection of alkaloids. Estimation of LD50 and ED50. Demonstration of drug toxicity.

Suggested Readings

1. Aquatic Toxicology. American Society for Testing and Materials, Philadelphia 1980.
2. Brown KM. 2000. Applied Fish Pharmacology. Kluwer Academic Press, London.
3. Derelanko MJ. 1995. CRC Handbook of Toxicology. CRC Press, Boca Raton.
4. Hayes AW. 2008. Principles and Methods of Toxicology. CRC Press, U.S.A.
5. Herwig N. 1979. Handbook of Drugs and Chemicals used in the Treatment of Fish Diseases. Charles C Thomas, Springfield.
6. Hoboken NJ. 2010. A Textbook of Modern Toxicology. John Wiley and Sons.
7. Hyde W et al. 1977. Analytical Toxicology Methods Manual. IOWA State University Press, Ames.
8. Kram DJ. 2001. Toxicology Testing Handbook. Marcel Dekker, Inc., New York.
9. Malins DC. 1994. Aquatic Toxicology. Lewis Publishers, Boca Raton.
10. Metelev VV. 1983. Water Toxicology. Amerind Publishing Co Pvt Ltd, New Delhi.
11. Niesink RJM. 1996. Toxicology Principles and Applications. CRC Press, New York.
12. Pandey BN. 2011. Fisheries and Fish Toxicology. A P H Publishing Corporation, New Delhi
13. Pandey G. 2017. Fish Pharmacology and Toxicology. DPH, New Delhi.
14. Radostits M. 2000. Veterinary Medicine. Book power Publisher, China.
15. Rand GM. 1985. Fundamentals of Aquatic Toxicology. Hemisphere Publishing Corporation, Washington.
16. Singh ISB. 2003. Aquaculture Medicine. Cochin University 2003. 336p.
17. Stockopf MK. 1993. Fish Medicine. W.B. Saunders Company, London.
18. The Toxicology of Fishes. CRC Press, Boca Raton, 2008.

AAHM 302	FISH IMMUNOLOGY	2 (1+1)	SEM VI

Objectives

1. To impart knowledge on basic principles of fish and shellfish immunology
2. To understand the immune responses to infection by various fish pathogens and to offer scope for the development of disease protective/prevention measures against bacteria, fungi, viruses and parasites of fish

Theory

Introduction, brief history to immunology. Types of immunity: Innate and adaptive immunity, cell-mediated and humoral immunity, cells and organs of the immune system. Antigens – structure and types, epitopes, haptenes. Antibody – fine structure, classes with structure and functions, antigenic determinants on immunoglobulins. MHC complex – types, structure, and functions. Antigen-antibody interactions-principle, antigen recognition by B-cells and T cells. Antigen antibody reaction -

Precipitation and agglutination reactions. Microorganisms associated with fishes in health and disease. Defence mechanism in finfish and shellfish- specific and non-specific immune system. Pathogenicity and virulence. Sources of infection, transmission of disease-producing organisms, portals of infection. Immunity to bacteria, fungi and parasites. Role of stress and host defence mechanism in disease development. Vaccines - types of vaccines – whole-cell vaccine, purified macromolecules, recombinant –vector, DNA vaccines and multivalent subunit vaccines, modes of vaccine administration. Serological methods in disease diagnosis. Immunostimulants – types, mechanism of action, modes of administration. Immunoassays, immunodiffusion, ELISA, immunofluorescence, neutralization, radioimmunoassay, serotyping.

Practical

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 testimonies, diffusion, double immune-diffusion, radial immune-diffusion assay, ELISA. Methods of vaccine preparation and techniques of fish immunization.

Suggested Readings

1. Abbas AK. 1991. Cellular and Molecular Immunology. Saunders Publisher, Philadelphia
2. Anderson DP. 2003. Textbook of Fish Immunology. Narendra Publishing House, Delhi.
3. Cooper EL. 1982. Immunology and Immunization of Fish. Pergamon Press, New York.
4. Cooper EL. 1982. General Immunology. Pergamon Press, Oxford.
5. Elgert KD. 2009. Immunology. John Wiley and Sons, New York.
6. Fikrig SM. 1982. Handbook of Immunology for Students and House Staff. Verlag Chemic International, Florida.
7. Paul WE. 2008. Fundamental Immunology. Wolters Kluwer, USA.
8. Richard C. 2015. Immunology A Short Course. Wiley Blackwell, UK.
9. Sharma DK. 2015. Immunology. New India Publishing Agency, New Delhi.

AAHM 303	THERAPEUTICS IN AQUACULTURE	2 (1+1)	SEM VI

Objectives

1. To learn the principles and protocols of drugs in aquaculture
2. To impart knowledge of antibiotic used in aquaculture

Theory

Scope and current scenario of therapeutics in aquaculture. Chemotherapy: History, definition, terms used and classification of AMA. Antibacterial agents, mode of action, general principles, classification, Antibiotics, different classes and their mode of action, properties etc. Antibiotic resistance. Antiseptics and disinfectants. Anti

parasiticides: Ectoparasites, Endoparasites and Protozoans. Antibiotics used in aquaculture. 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. Therapeutants in aquaculture: Classification, pesticides, fungicides/ algicides, hormones, anaesthetics, flesh colour enhancers, Chemicals of therapeutic value. Law priority aquaculture drugs. Drugs used for structural material and substances for maintenance, substances connected with zoo technical practices. List of the drugs used in aquaculture with therapeutics.

Practical

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

Suggested Readings

1. Bryan LE. 1989. Handbook of Experimental Pharmacology. Vol 91. Springer-Verlag, Berlin.
2. Brown KM. 2000. Applied Fish Pharmacology. Kluwer Academic Press, London.
3. Herwig N. 1979. Handbook of Drugs and Chemicals used in the Treatment of Fish Diseases. Charles C Thomas, Springfield
4. Khory RN. 1999. Material Medica of India and their Therapeutics. KomalPrakashan, Delhi.
5. Lancaster R. 1980. Pharmacology in Clinical Practice. William Helnemann Medical Books Ltd., London
6. Moini J. 2009. Fundamental Pharmacology. Cengage Learning, New Delhi
7. Pandey G. 2017. Fish Pharmacology and Toxicology. DPH, New Delhi.

AAHM 202	LABORATORY TECHNIQUES FOR FISH PATHOGEN DETECTION	2 (0+2)	SEM IV

Practical

Fish and shellfish sampling techniques for disease diagnosis, necropsy procedures and tissue collection, microscopic identification of parasites, histological sectioning and staining techniques, media preparation and culture of pathogenic bacteria, biochemical characterization of bacterial isolates, antibiotic sensitivity testing using disc diffusion method, blood collection techniques from fish, blood smear preparation and staining, complete blood profile analysis including total and differential leucocyte counts, collection, separation and identification of fish leucocytes, isolation of macrophages, immunological techniques including agglutination tests, immunodiffusion assays and ELISA, nucleic acid extraction and quantification, agarose gel electrophoresis, PCR-based pathogen detection, use of commercially available diagnostic kits, cell culture techniques for virus isolation and purification, vaccine preparation methods, and techniques of fish immunization.

AAHM 401	FISH AND SHELLFISH PATHOLOGY	3 (2+1)	SEM VII

Objective

- To understand the structural and functional changes in cells, tissues and organs in relation to the development of various finfish and shellfish diseases.

Theory

General pathology: Brief introduction to finfish and shellfish anatomy and histology; General pathology of finfish and shellfish Pathophysiology of fish: Pathophysiology of finfish and shellfish; Stress and stressors; General adaptation syndrome; Types of cellular adaptations; Hypertrophy, hyperplasia, Atrophy and metaplasia, Neoplasia. Inflammation and cellular pathology: Reversible cellular changes and accumulations; Fatty changes and pigments; Inflammation; Causes of inflammation; Cellular responses to inflammation; Mediators; various patterns of inflammation; The difference between acute and chronic inflammation; Tissue repair; Cell death; Necrosis, Apoptosis, Autophagy; Necroptosis; Their mechanisms and different morphological patterns. Clinical pathology: Normal constituents of blood; Alterations in the haematological parameters and enzymes with reference to different pathological conditions in finfish; Haematology of shrimp and molluscans; Clotting mechanisms; other host defence mechanisms.

Systemic pathology of finfish: Systemic pathology of finfish integumentary system, Respiratory system, Vascular system, Digestive system, Excretory system, Nervous system, Musculoskeletal and Endocrine system due to bacteria, Parasites and viruses. Systemic pathology of shellfish: Major pathological changes due to infectious diseases in the integumentary system, Lymphoid organ, Gill, Hepatopancreas, Gut and other organs of crustaceans; Major pathological changes due to diseases in molluscans.

Practical

Necropsy techniques. Collection and fixation of tissues. Complete histology and different staining techniques. Examination and interpretation of the pathological changes in fish tissues. Complete blood profile of finfish. Routes of blood collection from fish. Different staining techniques for blood cell visualization. Morphology of blood cells. Total leucocyte count. Differential leucocyte count.

Suggested Readings

1. Coleman WB. and Tsongalis GJ. 2009. Molecular Pathology. Elsevier Publisher, Boston.
2. Ellis AE. 1985. Fish and Shellfish Pathology. Academic Press, London.
3. Ferguson HW. 2006. Systematic Pathology of Fish. Scotain Press, London.
4. Killeen AA. 2001. Molecular Pathology Protocols. Humana, U.S.A
5. Lloyd RV. 2004. Endocrine pathology. Humana Press, Totowa.
6. Roberts RJ. 2012. Fish Pathology. Wiley-Blackwell, Chichester.
7. Salle AJ. 1961. Fundamental Principles of Pathology. MacGraw-Hill Co., New York.

AAHM 402	DISEASE DIAGNOSTIC TECHNIQUES	3 (2+1)	SEM VII

Objective

To comprehend theoretical and practical aspects of different disease diagnostic techniques used in aquaculture and to take appropriate decisions on fish health management and appropriate choice of treatment

Theory

Introduction to fish disease diagnosis: Introduction to disease diagnosis; different roles and levels of diagnosis in aquaculture; The evolution of diagnostic techniques in aquaculture; A brief introduction to diagnostic features of important diseases of finfish and shellfish. Microbiological techniques: Safety in microbiology laboratory; Bio-safety levels and risk groups; Techniques in sterilization; Preparation of microbiological media. Culture Microscopic techniques: Bright field, Darkfield, Phase contrast, Fluorescence and electron microscopy. Cell culture-based diagnostic methods: Introduction to cell culture techniques; Different cells used for virus isolation; CPE. Protein-based diagnostic methods: Antibody-based diagnostic methods (immunohistochemistry, ELISA, western blotting, lateral flow assay etc.), Hybridoma technology and monoclonal-antibody based diagnosis Nucleic-acid based diagnostic methods: Nucleic acid amplification methods; Types of PCR: Reverse transcriptase-PCR, Real-time PCR and Other variants of PCR; In situ hybridization; Dot blot assay; LAMP etc.

Practical

Sample collection and preparation for microscopic, microbiological, virological and histopathological analysis. Culture of microorganisms using conventional methods. Antibiotic sensitivity testing. Serological techniques in disease diagnosis: SDS-PAGE, Western blotting, ELISA, etc. Cell culture techniques; Molecular techniques in disease diagnosis, Nucleic acid extraction, estimation and different PCR-based diagnosis. Familiarization of some of the commercially available diagnostic kits used in aquatic animal disease diagnosis.

Suggested Readings

1. Infectious Disease in Aquaculture. Woodhead Pub. Ltd., Philadelphia, 2012.
2. Lucky Z. 1977. Methods for the Diagnosis of Fish Diseases. Amerind Publishing Co Pvt Ltd, New Delhi.
3. Sindermann CJ. 1977. Disease Diagnosis and Control in North American Marine Aquaculture. Elsevier Scientific Publishing Company, Amsterdam.
4. Sugama K. 1998. Manual of Fish Diseases Diagnosis. Nippon veterinary and animal science University, Japan.
5. Walker P. 2005. DNA-based Molecular Diagnostic Techniques. Daya, Delhi.

AQUATIC ENVIRONMENT MANAGEMENT

Course No.	Course Title	Credits	Semester
Core Courses			
AEM 101	Soil and Water Chemistry	3 (2+1)	I
AEM 102	Meteorology and Geography	2 (1+1)	I
AEM 103	Limnology	2 (1+1)	II
AEM 301	Marine Biology	2 (1+1)	V
AEM 302	Aquatic Ecology and Biodiversity	2 (1+1)	V
AEM 303	Coastal Zone Management	2 (1+1)	VI
	Total Credits	**13 (7+6)**	
Skill Enhancement Course			
AEM 104	Analytical Techniques (Testing of Water, Soil, Feed etc.)	2 (0+2)	II
	Total Credits	**2 (0+2)**	
Elective Courses			
AEM 401	Aquatic Pollution	3 (2+1)	VII
AEM 402	Fishery Oceanography	3 (2+1)	VII
AEM 403	Analytical Techniques in Aquatic Environmental Studies	3 (2+1)	VII
AEM 404	Aquatic Microbiology	2 (1+1)	VII
AEM 405	Climate Change and its Impact on Fisheries	2 (2+0)	VII
	Total Credits	**13 (9+4)**	
	Grand Total	**28(16+12)**	

AEM 101	SOIL AND WATER CHEMISTRY	3 (2+1)	SEM I

Objectives

1. To analyse the water and soil quality parameters in relation to aquaculture for assessing the health of the water bodies
2. To study the impact of water and soil quality parameters on fish and shellfish production

Theory

Analytical chemistry: principles, applications and types. Classical methods of analytical chemistry, volumetry and gravimetry. Solutions: Standard solutions, titration, indicators, dilute solutions, units of concentration: standard curve, nomograph. 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. Dissolved gasses: Factors affecting natural waters. Acid, base, salts, Hydrogen ions, modern concept of pH and buffer. Water analysis: collection and preservation of water samples. Measurement of temperature. transparency, turbidity, determination of pH, electrical conductivity, salinity, chlorinity, total solids (TDS, TSS, TVS, TVDS), dissolved oxygen, free carbon dioxide, total alkalinity, total hardness, Calcium, Magnesium, Inorganic Nitrogen (Ammonium and Nitrate) and phosphorus. Water quality criteria/ requirements for Aquaculture.

Soil Chemistry: Origin and nature of soils. Physical properties of soil; soil colour, texture, structure, pore size, bulk density, water holding capacity. Soil types and their distribution. Soil chemistry: soil colloids, cation exchange, organic carbon, Carbon - Nitrogen ratio, soil fertility. Soil reaction: acidity, alkalinity, conductivity, redox - potential. Submersed soils: wet lands, peat soils, fluxes between mud and water, methane and hydrogen sulphide formation. Saline soils, Alkali soils, acid sulphate soils, iron pyrites, and soil reclamation.

Soil analysis: collection and preparation of soil samples, determination of soil texture, water holding capacity, pH, conductivity, organic carbon, nitrogen, phosphorus, lime requirement. Soil and water amendments: lime manures, fertilizers, micronutrients, zeolites, alum, gypsum. Environmental ameliorative: chlorination, deodorizers, bacterial formulation. Soil quality criteria/requirements for aquaculture.

Practical

Principles of Titrimetry, Gravimetry, Potentiometry, Conductometry, Refractometry, Colourimetry, Turbidimetry, Spectrophotometry (UV, Visible, Flame, AAS), computerized instrument system. 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, Free CO2. Determination of total alkalinity, hardness. Determination of inorganic nitrogen, and phosphorus.

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

Suggested Readings

1. APHA (American Public Health Association). 2017. Standard Methods for the Examination of Water and Wastewater. 23rd Edition. American Public Health Association, Washington, D.C
2. Boyd, C.E., Wood, C.W. and Thunjai, T. 2002. Aquaculture pond bottom soil quality management. Oregon State University, Corvallis, Oregon.
3. Bryan M Ham and AihuiMaHam. 2016. Analytical Chemistry: A Chemist and Laboratory Technician's Toolkit, Wiley.
4. Cheremisinoff NP. 2002. Handbook of Water and Waste Water Treatment Technologies. Butterworth – Heinemann, Woburn.
5. Jeffery GH, Basset J, Mendham J and Denney RC. (Eds). 1989. Vogel's Textbook of Quantitative Chemical Analysis. Longman Publishers, Singapore.
6. Sparks DL, Page AL, Helmke PA, Loeppert RH, Soltanpour PN, Tabatabai MA, Johnston CT and Sumner ME. (Eds). 1996. Methods of Soil Analysis: Part 3 - Chemical Methods. SSSAASA, Madison.

AEM 102	METEOROLOGY AND GEOGRAPHY	2 (1+1)	SEM I

Objective

To teach the meteorological phenomena and geographical distribution

Theory

Nature of Atmosphere: weather and climate; composition of atmosphere; structure of atmosphere. Heat energy of atmosphere: the process of heat transmission; heating of atmosphere; disposal of insulation; irregular heating of the atmosphere. Temperature: Temperature instruments; periodic, horizontal and vertical temperature variations; effects of vertical air motion on temperature. Humidity and water vapour: the relationship between temperature and humidity; distribution of water vapour in atmosphere; evaporation, humidity instruments and measurements.

Condensation and precipitation: process of conditions of condensation, forms of condensation; precipitation; forms of precipitation, measurement of precipitation; rainfall in India. Clouds and thunderstorms: amount of cloudiness; ceiling; classification of clouds; conditions of cloud formation; reporting and identification of clouds; thunderstorms.

Atmospheric pressure: meaning of atmospheric pressure; the laws of Gases; pressure units; pressure instruments; vertical, horizontal and periodic variations; isobars and pressure gradients.

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. Planetary wind system; secondary winds; monsoon winds; land and sea breeze. Tropical cyclones: storm divisions; pressure and winds; vertical structure of storm centre; hurricane, sea, swell and surge; hurricane warning.

Weather forecasting: forecasting process; forecasting from local indications; role of satellite in weather forecasting; synoptic weather charts. Effects of climate change on fisheries sector.

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.

Practical

Graphic representation of the 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 means 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. Wind observation 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

1. Ahrens, C. Donald. 2011. Essentials of Meteorology: An Invitation to the Atmosphere, International Edition, Brooks/Cole Publ.
2. Barry Roger G. 2009. Atmosphere, Weather and Climate, Taylor and Francis Ltd.
3. Maury, Matthew Fontaine. 2018. The Physical Geography of the Sea, and Its Meteorology, Palala Publ.
4. Naik M. Ganapathi . 2013. Meteorology and Geography, Narendra Publishing House.
5. Spiridonov V. 2021. Fundamentals of Meteorology, Springer.
6. The Indian Meteorological Department (IMD), Weather Instruments, Maps and Charts, In Practical Geography. 2022-23.

AEM 103	LIMNOLOGY	2 (1+1)	SEM II

Objectives

1. To study the limnetic environment
2. To understand the physico-chemical and biological characters of the limnetic environment

Theory

Introduction to limnology: inland water types, their characteristics and distribution; ponds and lakes; streams and rivers; dynamics of lentic and lotic environments. 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: influence of physical and chemical conditions on living organisms in inland waters. Plankton: planktonic organisms; classification of 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; primary productivity: Aquatic plants: characteristics, classification, zonation, seasonal variations, quantity produced chemical composition distribution in different waters, limnological role. Nekton: composition, distribution, movements. Benthos: classification; periphyton; zonation; distribution; movements and migration; seasonal changes in benthos, profundal bottom fauna. Biological productivity: circulation of food material; classification of lakes based on productivity; laws of minimum; biotic potential and environmental resistance; quantitative relationships in a standing crop; trophic dynamics; successional phenomena; indices of productivity of lakes; artificial enrichment. Lotic environments: running waters 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 streams; ecological succession.

Practical

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 freshwater phytoplankton. Enumeration and biomass estimation of freshwater phytoplankton. Estimation of primary productivity in freshwater bodies. Collection and identification of freshwater zooplankton. Enumeration and biomass estimation of freshwater 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 freshwater bodies. Field visit to lotic and lentic water bodies.

Suggested Readings

1. APHA 2017. Standard Methods for the Examination of Water and Wastewater, American Public Health Association, Washington DC.
2. Bryan M Ham and AihuiMaHam. 2016. Analytical Chemistry: A Chemist and Laboratory Technician's Toolkit. Wiley.
3. Claude E Boyd. 1995. Bottom Soils, Sediment, and Pond Aquaculture, Chapman and Hill
4. Cole, G. A. and Weihe, P.E. 2015. Textbook of Limnology, Waveland Pr. Inc.
5. DattaMunshi, J. 2015. Fundamentals of Limnology, Daya Publ. House.
6. Dodds WK. 2002. Freshwater Ecology: Concepts and Environmental Applications. Academic Press, New York.
7. Edmondson WT. 2003. Freshwater Biology. Textbook Publishers, 1248 pp.
8. Essington ME. 2003. Soil and Water Chemistry: An Integrated Approach, CRC Press.
9. Fasset NG. 1997. A Manual of Aquatic Plants. Allied Scientific Publishers, Bikaner.
10. Jose GaliziaTundisi, J.G and Takako Matsumura Tundisi, T.M. 2011. Limnology. CRC Press, London, 888pp.
11. Mitsch WJ. 2009. Wetland Ecosystems. John Wiley and Sons. 295 pp.
12. Nath S. (Ed). 2008. Recent Advances in Fish Ecology Limnology and Eco Conservation Vol 7. Narendra Publishing House, New Delhi.
13. Tan KH. 1998. Principles of Soil Chemistry. CRC Press Inc., Boca Raton.
14. Wetzel, R. G. 2010. Limnology. Saunders Publ. 858pp.

AEM 301	MARINE BIOLOGY	2 (1+1)	SEM V

Objectives

1. To understand the Marine life and its biology
2. To study the diversity of marine organism

Theory

Introduction to Marine Biology: Divisions of marine environment- pelagic, benthic, euphotic, aphotic divisions and their subdivisions. Life in oceans - general account of major groups of phytoplankton, zooplankton and seaweeds. Environmental factors affecting life in the ocean salinity, temperature, light, currents, waves, tides, oxygen, and carbon dioxide. Vertical migration of zooplankton, Phytoplankton-Zooplankton relationship, geographical and seasonal variation in plankton production, plankton

and fisheries. Inter tidal ecology: Rocky shore, sandy shore and mud flats, zonation, communities, and the adaptation. Mud banks: formation and characteristics. Estuaries: Classification, Physico-chemical factors, Biota and productivity, examples of some Indian Estuaries. Boring and fouling organisms. Nekton outline, composition of nekton, habitats of nekton. Bioluminescence and indicator species. Blooms, Red tides: cause and effects.

Practical

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

Suggested Readings

1. Cass-Dudley, V. L., Dudley G. and Sumich, J.L. 2016. Laboratory and Field Investigations in Marine Life. 11th edn, Jones and Bartlett Learning.
2. Castro, P. and Huber, M.E. 2018. Marine Biology, McGraw Hill.
3. Derek Burton, D. and Burton, M. 2017. Essential Fish Biology: Diversity, structure, and function, Oxford University Press.
4. Kennish MJ. 1989. Practical Handbook of Marine Science. CRC Press, New York.
5. Laevastu T and Hayes ML. 1981. Fisheries Oceanography and Ecology. Fishing News Books, Farnham, U.K.
6. Lalli CM and Parsons TR. 1993. Biological Oceanography: An Introduction. Elsevier Science Ltd., Oxford.
7. Miller CB. 2004. Biological Oceanography. Blackwell Publications, Oxford.
8. Pond S and Pickard GL. 2013. Introductory Dynamical Oceanography. Elsevier
9. Reddy MPM. 2007. Ocean Environment and Fisheries, Science Publishers, USA.

AEM 302	AQUATIC ECOLOGY AND BIODIVERSITY	2 (1+1)	SEM V

Objectives

1. To enrich the knowledge on the ecology and biodiversity of aquatic environment
2. To assess the threats on the ecosystem and biodiversity of aquatic environment

Theory

Aquatic environment, Flora and fauna: Components of aquatic systems. Aquatic productivity, nutrient cycles, energy flow, food chain. Animal associations: Symbiosis, commensalisms, parasitism, prey-predator relationship, host-parasite relationship. Aquatic biodiversity-its importance, species diversity, genetic diversity, habitat diversity, diversity indices. Ecological and evolutionary processes. Ecological niches – lagoons, estuaries, mangroves, coral reefs, flood plains, coastal wetlands, bheels, oxbow lakes. Threats to biodiversity- habitat destruction, introduction of exotic species. Conservation of habitats: marine parks and sanctuaries. Conservation programs 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.

Practical

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. Collection, identification, and preservation of mangrove plants. Working out biodiversity indices.

Suggested Readings

1. Andy D Ward, Stanley W Trimble, Suzette R Burckhard and John G Lyon. 2015. Environmental Hydrology, CRC press.
2. Barnes RSK and Mann KH. eds. 2009. Fundamentals of aquatic ecology. John Wiley and Sons.
3. Carter RWG. 1998. Coastal Environments: An Introduction to the Physical, Ecological and Cultural Systems of Coastlines. Academic Press, London.
4. Dodds W and Whiles M. 2010. Freshwater Ecology, 2nd edn, Concepts and Environmental Application of Limnology. Academic Press, London.
5. Dodds WK. 2002. Freshwater Ecology: Concepts and Environmental Applications. Academic Press, New York.
6. Elliott A. Norse (Ed.) 1993. Global marine Biological Diversity. Inland press, Washington, D.C.383p.
7. Khanna DR, Chopra AK and Prasad G. 2005. Aquatic Biodiversity in India. Daya Publ. House.
8. Kormondy EJ. 1986. Concepts of Ecology, Prentice-Hall, New Delhi.
9. Kumar U and Asija MJ. 2000. Biodiversity Principles and Conservation. Agrobios.
10. Magurran AE. 1988. Ecological Diversity and its Measurement. Taylor and Francis.
11. Menon AGK. 2004. Threatened Fishes of India and their Conservation. Fisheries Survey of India.
12. Mitsch WJ. 2009. Wetland Ecosystems. John Wiley and Sons. 295 pp
13. Nath S. (Ed). 2008. Recent Advances in Fish Ecology Limnology and Eco Conservation Vol 7. Narendra Publishing House, New Delhi
14. Okuda N, Watanabe K, Fukumori K, Nakano SI and Nakazawa T. 2014. Biodiversity in aquatic systems and environments: Lake Biwa. Springer Japan.
15. Thorpe JE, Talbot C and Miles MS. (Ed.) 1995. Conservation of Fish and Shellfish Resource; Managing Diversity. Academic Press.

AEM 303	COASTAL ZONE MANAGEMENT	2 (1+1)	SEM VI

Objectives

1. To impart knowledge on the importance of coastal zones for human society
2. To teach the students on the different management strategies for the conservation of coastal zones
3. To impart fundamental and advanced knowledge on the sources of pollution and its controlling measures

Theory

Estuaries, Wetlands and Lagoons, Living resources – Non-living resources. Principles of remote sensing: orbits, electromagnetic radiation, diffraction, electro-optical, and microwave systems. Data Input, Data Management, Data Quality. Remote Sensing for Coastal Management. Geographical Information System (GIS): Definition, Concepts, Data Acquisition and Data Management. Applications of GIS in aquatic resource identification. Coastal Regulation Zone (CRZ) Act, Coastal regulation zones for mainland and islands – Environmental policies, planning, administrative and regulations. CRZ mapping. Integrated Coastal Zone Management (ICZM); concept, application, and case studies. Communication, research, integration, institutional arrangements, regulations, stakeholder participation, the role of the private sector in ICZM. 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; Analysis of multiple use management problems typical for the coastal areas with the maritime industry. Environmental Impact Assessment (EIA): Principles and process. EIA of coastal industries. Evaluation and Methodology; Social Impact Assessment and other developmental activities.

Practical

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. 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 to combat disaster. Field visits to mangroves, marine parks, sanctuaries, coral reefs, rivers, hills, streams, lakes and reservoirs. Working out biodiversity indices. Project preparation of EIA.

Suggested Readings

1. Cairns J Jr. 1994. Implementing Integrated Environmental Management Virginia Tech University.
2. Clark JR. 1992. Integrated Management of Coastal Zones. FAO Fisheries Technical Paper No. 327, Rome.
3. Coastal Area Management and Development 1982. U.N. Department of International Economic and Social Affairs, New York.
4. Ramkumar M, James A, Menier D, Kumarswamy K. 2018. Coastal Zone Management: Global Perspective, Regional Processes, Local Issue. Elsevier

AEM 104	ANALYTICAL TECHNIQUES (TESTING OF WATER, SOIL, FEED ETC.)	2 (0+2)	SEM II

Objectives

1. To acquaint the student to the instrumentation employed in aquatic environmental studies
2. To teach the student analytical techniques employed in water, soil and fish feed analysis

Practical

Qualitative and quantitative analytical techniques including gravimetric and volumetric analyses used in aquatic environmental studies. Sampling techniques and procedures. Laboratory safety measures. Collection and preservation of water and soil samples. Analysis of water quality parameters: measurement of temperature, turbidity, transparency, total solids, determination of pH, electrical conductivity, salinity, chlorinity, DO, BOD, free CO_2, total alkalinity, total hardness, calcium, magnesium. Determination of ammonia-N, nitrite-N, nitrate-N, phosphate-P etc. Soil quality parameters: Determination of soil texture, soil pH, soil conductivity, organic carbon, available nitrogen, available phosphorus etc. Analysis of proximate composition of fish feed ingredients: Crude protein, crude fat, moisture, crude fibre, ash and carbohydrate etc.

AEM 401	AQUATIC POLLUTION	3 (2+1)	SEM VII

Objectives

1. To impart knowledge on different aspects of aquatic pollution
2. To impart fundamental and advanced knowledge on the sources of pollution and its controlling measures

Theory

Introduction to aquatic pollution, the sources of pollutants, toxic organic compounds and their impacts in the aquatic organisms and the abiotic environment. Classification of pollution; Physical, chemical and biological classification of water pollution-description of terminologies. Sewage and domestic wastes; composition and pollution effects, sewage treatment and its reuse. Agricultural wastes; organic detritus, nutrients, Adverse effects of oxygen demanding wastes: importance of dissolved oxygen; Oxygen demand (BOD, COD), Oxygen budget; Biological effects of organic matter. Excessive plant nutrients: Eutrophication; Red tides and fish kills. Pesticide types and categories; inorganic pesticides, Organo-chlorine compounds, Organo-phosphorous compounds; Polychlorinated biphenyls (PCBs); Bioaccumulation and impact on aquatic fauna and human health; toxicology. Heavy metals: Interaction of heavy metals with water and aquatic organisms. Bioremediation and Phytoremediation. Oil pollution; Crude oil and its fractions; Sources of oil pollution; Treatment of oil spills at sea; Beach Cleaning; Toxicity of Petroleum Hydrocarbons; Ecological Impact of Oil pollution - Case studies. 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; Biofilms and Biocorrosion; Radioactivity and background radiation of earth: Radionuclide polluting, special effects of radioactive pollution. 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. Solid waste management.

Practical

Estimation of physio-chemical characteristics of polluted waters: Colour, Odour, Turbidity, pH, salinity, total alkalinity, total hardness, BOD, COD, Hydrogen sulphone, phosphates, ammonia, nitrates, nitrites, heavy metals and Oil and grease in water. Determination of pH, conductivity, organic carbon, nitrogen, phosphorus, heavy metals in sediments. Bacteriological tests of wastewater: Coliform tests, IMVIC test, standard plate count. Methods of enumerating bacterial biomass in waters and waste waters. Study of flora and fauna of polluted water, pollution indicator species (algae, protozoa and insect larva), bioassay and methods of toxicity study.

Suggested Readings

1. APHA (American Public Health Association). 2017. Standard Methods for the Examination of Water and Wastewater. 23rd edn. American Public Health Association, Washington, D.C.
2. Baird DJ, Beveridge MCM, Kelly LA and Muir JF. 1996. Aquaculture and Water Resources Management. Blackwell Science Ltd., Oxford.
3. Clark RB. 2001. Marine Pollution. Oxford University Press.
4. Czernuszenko W and Rowinski P. 2005. Water Quality Hazards and Dispersion of Pollutants. Springer Science and Business Media.
5. Gray NF. 2004. Biology of Wastewater Treatment. Oxford University Press, London.
6. Mason C. 2002. Biology of Freshwater Pollution. 4th edn, Benjamin Cummings, 400 pp.

AEM 402	FISHERY OCEANOGRAPHY	3 (2+1)	SEM VII

Objectives

1. To educate the students on the oceanographic concepts related to fisheries and impart skill to operate oceanographic equipment
2. To understand the role of different oceanographic parameters on fisheries production

Theory

Introduction to Oceanography: classification; expeditions national and international. Earth and the ocean basin, distribution of water and land; relief of sea floor; Major feature of topography and terminology; major divisions. Relief in Indian oceans. 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, Seiches, internal waves. Ocean Tides: Definition; Tidal phenomenon, elementary tidal definition; tidal

inequalities; tide producing forces types of tides tidal bores, tide prediction. Ocean Currents: Definitions and features; measurements of currents; direct and indirect methods forces acting on sea waters; drift currents, Ekman spirals, upwelling, sinking, gradient currents; thermohaline circulation; characteristics; course; and significance of some major ocean currents of the world. El Nino and Southern Oscillation. Physical properties of sea water: Salinity and chlorinity; temperature; 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; eddy conductivity; diffusivity and viscosity. General distribution of temperature, salinity and density: Salinity and temperature of surface layer (SST), subsurface; distribution of temperature and salinity; The T-S diagram; water masses of Indian oceans. Chemistry of sea water: Constancy of composition; elements present in sea water; artificial sea water; dissolves gases in sea water; CO2 system and alkalinity; inorganic agencies affecting composition of sea water distribution of phosphorus, nitrogen compounds, silicates and manganese in the oceans, factor influencing their distribution. Environmental factors influencing the seasonal variations in fish catch in the Arabian Sea and the Bay of Bengal.

Practical

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. Use of tide tables. Fisheries forecasting systems. Oceanographic equipment and fish-finding devices.

Suggested Readings

1. Grasshoff K, Ehrhardt M and Kremling V. 1983. Methods of Seawater Analysis. VerlagChemie, Weinheim.
2. Kennish MJ. 1989. Practical Handbook of Marine Science. CRC Press, New York.
3. Laevastu T and Hayes ML. 1981. Fisheries Oceanography and Ecology. Fishing News Books, Farnham, U.K.
4. Lalli CM and Parsons TR. 1993. Biological Oceanography: An Introduction. Elsevier Science Ltd., Oxford.
5. Miller CB. 2004. Biological Oceanography. Blackwell Publications, Oxford.
6. Pond S and Pickard GL. 2013. Introductory Dynamical Oceanography. Elsevier.
7. Reddy MPM. 2007. Ocean Environment and Fisheries, Science Publishers, USA.
8. Tomczak M and Godfrey JS. 2013. Regional Oceanography: An Introduction. Elsevier.

AEM 403	ANALYTICAL TECHNIQUES IN AQUATIC ENVIRONMENTAL STUDIES	3 (2+1)	SEM VII

Objective

To teach the student advance analytical techniques in aquatic environment studies

Theory

Qualitative and quantitative analytical techniques including Gravimetric and volumetric analyses used in environmental science, Sampling techniques and procedures, Factors affecting the choice of analytical techniques, Interferences and their minimization, Laboratory safety measures. Photometric techniques: Theory, instrumentation and application of spectrophotometry and spectroscopy, AAS, ICP-MS, Biosensor, Microscopic Techniques etc. Theory and applications of electrophoresis, Principles and uses of ultra-centrifugation, Tracer Techniques, Isotopes in environmental analysis. Separation techniques: Chromatography – theory, instrumentation and applications of thin layer, paper, ion-exchange, size exclusion, high performance liquid and gas chromatography. Methods of preparing biological samples for chromatographic analysis GC-MS Unit. Bioanalysis techniques: Immunoassay – Principle, methods and applications and Biosensors – components, characteristics, applications, impacts and challenges. Nanotechnology: Preparation of nanoparticles, characterization and applications.

Practical

Eutrophication studies in natural waters - tanks and ponds Estimation of bio-indicator organisms in polluted waters. Bioremediation experiments using different bio-agents. Use of UV visible Spectrophotometer for phosphate, nitrate other ions. AAS for analysis of heavy metals. Use of HPLC and GC-MS for analysis of pesticide and other volatile and semi volatile organic substances.

Suggested Readings

1. APHA (American Public Health Association). 2017. Standard Methods for the Examination of Water and Wastewater. 23rd edn. American Public Health Association, Washington, D.C.
2. Cheremisinoff NP. 2002. Handbook of Water and Waste Water Treatment Technologies. Butterworth – Heinemann, Woburn.
3. Cairns JE. 2017. Biological Monitoring in Water Pollution. Elsevier.
4. Sakhare VB. (Ed.). 2007. Advances in Aquatic Ecology. Vol. 1. Daya Publishing House, New Delhi.

AEM 404	AQUATIC MICROBIOLOGY	2 (1+1)	SEM VII

Objective

To impart knowledge on aquatic microorganisms with reference to their role in the aquatic environment and bioprospecting.

Theory

Distribution and classification: Microbial community in freshwater; Estuarine and marine environment (types and abundance); Factors affecting microbial growth and abundance. Microbial interaction: Microbial degradation of persistent organic pollutants (POPs); Microorganisms and public health: Water-borne pathogens of public health importance - Protozoans, bacteria, enteroviruses; Microbial toxins; Algal toxins; Disinfection methods; Microbial standards for different water uses. Principles and applications of bioprocesses: Bioremediation, Biofertilization,

Biofilms, Biofloc, Probiotics, Bio-leaching, Bio-corrosion, Bio-fouling; Microorganisms as Bioindicators and Biosensors. Methods of assessing microbial biomass production; Bioprospecting: Current practices in bioprospecting and biopiracy; Microbial metabolites and its industrial application.

Practical

Isolation, identification and enumeration of algae and bacteria from polluted aquatic habitats. Maintenance of algal and bacterial cultures. Microbial sensitivity testing. Bio-activity testing. Disinfection methods.

Suggested Readings

1. Dhevendaran K. 2008. Aquatic Microbiology, Daya Publishing House, New Delhi.
2. Droop MR and Jannasch HW. 2012. Advances in Aquatic Microbiology. Volume One. Academic Press, 388 pp.
3. Frobisher M, Hinsdill RD, Crabtree KT and Goodheart CR. 1974. Fundamentals of Microbiology. WB Saunders Company, Philadelphia.
4. Maier RM, Pepper IL and Gerba CP. 2009. Environmental Microbiology. 2nd edn, Academic Press, 624 pp.
5. Rheinheimer G. 1992. Aquatic Microbiology. John Wiley and Sons.
6. Sigee, D.C. 2005. Freshwater microbiology. Wiley Publisher, 517pp.
7. Vernam AH and Evans M. 2000. Environmental Microbiology. Blackwell Publishing, U. K

AEM 405	CLIMATE CHANGE AND ITS IMPACT ON FISHERIES	2 (2+0)	SEM VII

Objectives

1. To understand global warming, its impact on the aquatic environment and fisheries
2. To know about the different legislation across the country to combat climate change

Theory

Weather and climate, Greenhouse effect, Radiative balance, Climatic migration, Carbon Sequestration and trading, Projected trends of climate change and disasters. Climate change, its impacts, Aquatic ecosystem, Capture and culture fisheries, Carbon footprint in fisheries and aquaculture. Oceanographic factors in fisheries: Effects of physio-chemical and biological oceanographic factors on adaptation; Behaviour, abundance and distribution of aquatic organisms; Primary and secondary productivity in ocean under changing climate. Ocean acidification, Global Ocean circulation, Upwelling and circulation patterns, El Nino and Southern Oscillation, IPCC and its reports, UNFCCC, Kyoto Protocol, Politics of climate change. Forecasting systems: Fisheries forecasts – Interpretation and use of ocean thermal structure; Fisheries forecasting system in India and other countries: Application of Remote sensing and GIS in fisheries; Application of echosounders and SONAR;

Potential fishing zones. Factors affecting marine fisheries. Adaptation and mitigation measures for Climate change; Vulnerability assessment; Climate-resilient aquaculture; Climate-smart villages.

Suggested Readings

1. Grasshoff K, Ehrhardt M and Kremling V. 1983. Methods of Seawater Analysis. VerlagChemie, Weinheim.
2. Kennish MJ. 1989. Practical Handbook of Marine Science. CRC Press, New York.
3. Laevastu T and Hayes ML. 1981. Fisheries Oceanography and Ecology. Fishing News Books, Farnham, U.K.
4. Lalli CM and Parsons TR. 1993. Biological Oceanography: An Introduction. Elsevier Science Ltd., Oxford.
5. Miller CB. 2004. Biological Oceanography. Blackwell Publications, Oxford.
6. Reddy MPM. 2007. Ocean Environment and Fisheries, Science Publishers, USA.
7. Hulme M. 2009. Why we disagree about climate change: Understanding controversy, inaction and opportunity. Cambridge University Press.
8. Murphy RP and Boomer D. 2008. An Appeal to Reason: A Cool Look at Global Warming, By Nigel Lawson-super-1. Economic Affairs, 28(4), pp.80-81.
9. Schmutter K, Nash M and Dovey L. 2017. Ocean acidification: assessing the vulnerability of socioeconomic systems in Small Island Developing States. Regional environmental change, 17(4), pp.973-987

FISH ENGINEERING

Course No.	Course Title	Credits	Semester
Core Courses			
FE 201	Fishing Craft Technology	2 (1+1)	III
FE 202	Fishing and Gear Technology	3 (2+1)	IV
FE 301	Aquaculture Engineering	3 (2+1)	V
FE 302	Refrigeration and Equipment Engineering	2 (1+1)	VI
FE 303	Navigation and Seamanship	2 (1+1)	VI
	Total Credits	**12 (7+5)**	
Skill Enhancement Course			
FE 203	Net Making and Mending	2 (0+2)	IV
	Total Credits	**2 (0+2)**	
Elective Courses			
FE 401	GIS and Remote Sensing in Fisheries	2 (1+1)	VII
FE 402	Responsible and Sustainable Fishing Methods	2 (1+1)	VII
	Total Credits	**4 (2+2)**	
	Grand Total	**18 (9+9)**	

FE 201	FISHING CRAFT TECHNOLOGY	2 (1+1)	SEM III

Objectives

1. To teach advanced aspects of fishing craft design
2. To learn about modification of existing craft layout

Theory

Introduction: History and development of fishing crafts. Traditional fishing crafts of India. Classification of fishing crafts based on fabrication dimension, nature of fishing, depth of operation. History and development of mechanization of fishing crafts. Basic geometric concepts and important terminologies of fishing vessel. Form coefficients, properties of irregular shapes Calculation of the longitudinal and transverse sectional area of fishing craft by using Trapezoidal rule and Simpson's rules. 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). Boat building materials: Choice of construction materials: Wood, properties, advantages and disadvantages. Deck fitting. Maintenance of fishing vessels. Fouling and boring organisms; seasoning and preservation of wood. Constructional details of boat: Offset tables; Mould lofting; Backbone assembly of wooden boat. Constructional details of Steel, FRP, Ferro Cement and Aluminium boats. Introduction of Outboard and inboard engines.

Practical

Studies on traditional fishing crafts; Introduction to drawing and drawing instruments; Lettering, Geometrical construction, Curves. Projections; Projection of points, planes and Projection of solids; lines plan drawing. Drawing of back bone assembly. U and V bottom hull of wooden boat. General view of boat; Drawing of sheer plan, body plan and half breadth plan. Types of marine engines and their installation of engines. Visit to boat building yard and dry dock.

Suggested Readings

1. Fyson JF. (ed). 1985. Design of Small Fishing Vessels, Fishing News Books, Oxford.
2. Pike D. 1992. Fishing Boats and Their Equipment. Fishing News Books. Oxford: 184p.
3. Ponnambalam A. 2003. Fishing Craft Technology. CIFNET. Cochin: 158p.
4. Sanisbury JC. 1996. Commercial Fishing Methods-an Introduction to Vessels and Gear, Fishing News Books Ltd., Farnham, 352p.
5. ShenoyLatha. 1988. Course Manual in Fishing Technology, CIFE, Mumbai, 95p.
6. Sreekrishna Y and ShenoyLatha. 2001. Fishing Gear and Craft Technology. Indian Council of Agricultural Research, New Delhi, 342p.
7. Yadav YS. 2002. Traditional Fishing Craft of the Bay of Bengal. BOBP. Chennai: 55p

FE 202	FISHING AND GEAR TECHNOLOGY	3 (2+1)	SEM IV

Objectives

1. To teach advanced fishing gear and fishing technology
2. To learn design modification and gear selectivity of fishing

Theory

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, methods of the world and International Standard Statistical Classification of Fishing gear (ISSCFG). 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 fibres and production of single yarns. Identification of synthetic fishing gear materials: Visual observation, water test, solubility test, burning test and melting point test.

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

Structure of various commercial fishing gears. Rigging of fishing gears: Bridles, sweep lines, otter boards, floats and ground gear arrangements. Otter door: Different types of otter doors. Behaviour of otter doors in water: Angle of attack, angle of heel and angle of tilt. Fishing accessories – thimbles, shackles, C-links, rings, G-links, Kelly's eye, stopper, bottle screw, Deck layout of different fishing vessels. Trawling: Beam trawling; otter trawling; side trawling; twin trawling out rig trawling bull trawling and mid-water trawling. Constructional details of single-boat purse seine; two-boat purse seine and method of operation. 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.

Line fishing: Types of hooks; structure and size of hooks. Constructional details of long line, tuna long line, vertical long line, pole and line and trolling line. Operation of long line: set and driftlong lining: bottom, mid-water and pelagic long lining; jigging. Operation of beach seine, boat seine and traps. Selectivity in fishing gear and by catch-reducing devices. Deck equipment – types of winches, net haulers, line haulers, triple drum, gurdy, power blocks, fish pumps. Fishing equipment: Fish finder, GPS navigator, sonar, net sonde, gear monitoring equipment.

Practical

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. 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.

Survey of fishing gears; Trawl; gillnet; long line and purse seine fishing gears. Rigging of trawl, purse seine, gillnet and hook and line. Commercial fishing techniques: Bottom trawling; purse seining; gillnetting and line fishing. Cast net fishing and trap fishing.

Suggested Readings

1. Ben-Yami M. 1994. Purse seining manual, FAO Fishing manual, 416p.
2. Biswas KP. 1996. Harvesting Aquatic Resources. Daya Publishing House – Delhi: 207 p.
3. Bjordal and Lokkeborg S. 1998. Long Lining, Fishing News Books Ltd. Farnham, 208p.
4. Brandt AV. 1984. Fish Catching Methods of the World. Fishing news books Ltd., London, 432p.
5. FAO. 1987. Small Scale Fishing Gear: 19 – 44pp.
6. FAO. 1996. Fishing Operations, FAO Training Guidelines for responsible fisheries No.1, FAO, Rome 26p
7. Fridman AL. 1986. Calculations for Fishing Gear Designs, FAO Fishing manual, Fishing News Books, Ltd., Farnham, 264p.
8. Kristionsson H. 1975. Modern Fishing Gear of the World. The White Friars Press Limited. London: 594 p.
9. Sreekrishna Y and ShenoyLatha. 2001. Fishing Gear and Craft Technology. Indian Council of Agricultural Research. New Delhi, 342p

FE 301	AQUACULTURE ENGINEERING	3 (2+1)	SEM V

Objectives

1. To acquire the knowledge of land survey, excavation of ponds, design and lay-out of fish/prawn farms.
2. To understand the basic knowledge for the construction of Finfish and Shellfish farms and hatcheries.

Theory

Fish Farm: Definition, objectives, types of farms; fresh water, brackish water and marine farms. 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 characteristics. Land Surveying: definition, principles of surveying, classification of surveying, instruments used for chaining, chaining on uneven or sloping ground and error due to the incorrect chain length. Chain surveying: definition, instruments used for setting out right angles, basic problems in chaining, cross-staff survey. Compass surveying: definitions, bearing, meridians, whole circle bearing system, reduced bearing system, theory of magnetic compass, prismatic compass. Levelling: definitions, methods of levelling, levelling instruments, terms and abbreviations, types of spirit levelling. Plane table surveying: instruments required, working operation, methods. Contour surveying: definition, contour interval, characteristics of contour, contouring methods and uses of contour. Soil and its properties: classification of soil; soil sampling methods; three-phase system of soil, definitions of soil properties and permeability of soil. Ponds: classification of ponds; excavated ponds, embankment ponds, barrage and diversion ponds; rosary system and parallel system. Planning of fishpond: layout planning, materials planning, manual planning, comparison of square and rectangular ponds, large and small ponds. Types of ponds: nursery ponds, rearing ponds and stocking ponds.

Design of ponds, pond geometry; shape, size, bottom slope of pond etc., construction ponds, marking, excavation. Dykes: types of dykes viz., peripheral dykes, secondary dyke, design of dykes, construction of dykes. Water distribution system: canal, types of canals; feeder canal, diversion canal etc., Pipeline system. Water control structures: types of inlets and outlets and their construction. 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. Site selection, planning and construction of coastal aqua farms. Brackish water fish farms: tide-fed, pump-fed farms. 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. Raceway culture system: site selection, layout plan, types of raceway culture system viz., parallel system, series system etc., Aerators: principles, classification of aerators and placement of aerators. Pumps: purpose of pumping, types, selection of pump, total head, horsepower calculation. Filters: types and constructions.

Practical

Evaluation of potential site for aquaculture. Land survey – chain surveying, compass surveying, levelling, 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 calculations. Visit to different types of farms.

Suggested Readings

1. Bose, A.N. Ghosh, S. N., Yang, C.T. and Mitra, A. 2009. Coastal Aquaculture Engineering, Cambridge University Press.
2. Mishra, R. and Dora, K.C. 2015. A text book on Aquaculture Engineering, Narendra Publishing House.
3. Odd-Ivar Lekang (Eeds.) 2013. Aquaculture Engineering, John Wiley & and Sons, Ltd.
4. Odd-Ivar Lekang, 2020. Aquaculture Engineering, 3rd eEdition, Wiley-Blackwell.
5. Wheaton, F.W. 1993. Aquaculture Engineering, Krieger Pub Co.

FE 302	REFRIGERATION AND EQUIPMENT ENGINEERING	2 (1+1)	SEM VI

Objectives

1. To teach engineering aspects about refrigerators, freezers
2. To learn about heat load calculation and COP
3. To teach electrical aspects of fishing vessel

Theory

Fundamentals: Force, work, power, energy, volume, pressure, temperature. Heat, specific heat, sensible heat, latent heat, comparison between heat and work - A path function. Thermodynamics: Laws of Thermodynamics, Laws of perfect gases, Thermodynamic processes, application of Fir stand Second law of Thermodynamics

in refrigeration, Thermodynamics cycle, entropy, enthalpy. Refrigeration: History of refrigeration, definition, principle, classification, Types of refrigeration systems i.e., Air refrigeration, vapour absorption refrigeration system. Vapour compression refrigeration system. Refrigeration plant: Layout of refrigeration plant, Construction and insulating materials used for the cold storage construction, Frozen product storage, capacity of cold storage, usage of Anteroom. Refrigeration systems: Vapour compression refrigeration system advantages and disadvantages as compared to other refrigeration systems, Types of Vapour compression refrigeration cycles i.e., Theoretical Vapour compression refrigeration cycle, Actual refrigeration cycle. Compressors: Definition, Types of compressors, construction, working principle, advantages and disadvantages. Evaporator: Definition, Types of Evaporators, construction, working principle, advantages and disadvantages. Condenser: Definition, Types of Condensers, Cooling Towers, construction, working principle, advantages and disadvantages. Expansion valve: Definition, Types of Expansion valve, construction, working principle advantages and disadvantages. Refrigerant: Primary refrigerant, secondary refrigerant, properties, ideal refrigerant, leakage detection. Study of auxiliary equipment: Receiver, oil charging, refrigerant charging, gas purging, oil draining, types of defrosting. Ice-plant: Ice plant planning, Brine tank construction, preparation of brine. Types of ice, storing of ice, Equipment used in ice plants. 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. Cooling load: Unit of refrigeration, coefficient of performance (C.O.P), Refrigeration effect, study, and use of Psychrometric chart. Cooling load estimation, introduction, components of cooling load, heat gain through walls, roofs, products, occupants, lighting equipment. Theory of machines: Transmission of power, friction wheels, shaft, gears, belt, and Chain drive. Study of equipment used in fish processing with reference to canning, sausage, freeze drying and irradiation. Maintenance: Definition, Types of maintenance, general maintenance of freezing plant, cold storage and ice plant.

Practical

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 equipment: Receiver, oil line diagram of different fish processing machineries. Visit to processing plant, refrigeration plant, ice plant. Visit to fishing harbour or landing centre to study the fish hold, refrigerated fish rooms. Calculation on refrigeration effect and cooling load.

Suggested Readings

1. Ayyappan VP. 2002. Elements of Electrical Technology. CIFNET. Cochin. 96p.
2. Joshy CD and Devadhason M. 2001. Basic Electronics and Fish Finding Equipment. CIFNET. Cochin: 42p.

3. Shawyer M and Medina Pizzali AF. The Use of Ice on Small Fishing Vessels. FAO. Rome: 102p.
4. Sternin UG, Nikonorou IV and Bumeister Yu K. 1976. Electrical Fishing. Keter. Publishing House Jerusalem Ltd. 258p.

FE 303	NAVIGATION AND SEAMANSHIP	2 (1+1)	SEM VI

Objectives

1. To learn engineering aspects of fish acoustic equipment
2. To learn navigation and seamanship for fishing vessel safety

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 points, pelorus and azimuth mirror, method of observation. Sextant - parts and functions, finding adjustable and nonadjustable errors and principles and use. Hand lead line – construction and markings and method of taking soundings. 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. 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. 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. Principles of seamanship- Causes of fire at sea, fire prevention on board the vessel and method of firefighting at sea and recommended firefighting appliances. Lifesaving appliances – life jackets, life buoys and method of operations and contents, SART and EPIRB. Observations of storms, formation of storms and method of locating the eye of the storms and method of escaping from the centre of the storms as per buys ballet law. Preparing vessels to face heavy weather. Temporary repairs for leaks constructions of the 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.

Practical

Anchoring, coming alongside 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. Finding set and drift of current and finding

course. Steering course and finding position by counter acting the current observation of RADAR.

Suggested Readings

1. CIFNET. 2004. Fishery Engineering: 212-238pp.
2. FAO. 1998. Fishing Operations. – Vessel Monitoring Systems, FAO Technical Guidelines for Responsible Fisheries No. 1, Suppl. 1, FAO Rome.
3. Joshy CD and Devadhason M. 2001. Basic Electronics and Fish Finding Equipment. CIFNET. Cochin: 31-42pp.
4. Larkin FJ. 1998. Basic Coastal Navigation, 2nd edn. Sheridan House Inc., New York: 273 p.
5. MacLennan DN and Simmonds EJ. 1992. Fisheries Acoustics, Fish and Fisheries Series 5, Chapman and Hall, London, 323 p.
6. Mitson RB. Fisheries SONAR. Fishing News Books Ltd. England: 274p.
7. Sreekrishnan Y and ShenoyLatha. 2001. Fishing Gear and Craft Technology. Indian Council of Agricultural Research, New Delhi, 342 p.

FE 203	NET MAKING AND MENDING	2 (0+2)	SEM IV

Objectives

1. To familiarize students with essential tools, knots, and techniques used in net making and mending
2. To develop practical skills in net shaping, cutting, joining, and mounting for effective fishing gear construction

Practical

Overview of net-making tools and equipment, knots, hitches, and bends for fishing gear construction, techniques in net making: hand braiding, chain mesh, and loop methods webbing shaping: baiting, creasing, and gradual mesh size reduction, tailoring techniques: webbing directions (t and n), and cutting methods (t-cuts, n-cuts, b-cuts), joining techniques for net sections, net mounting: understanding hanging coefficients, hung depth, and related calculations, selvedging techniques for net edges, net mounting methods: reeving, stapling, and norselling.

FE 401	GIS AND REMOTE SENSING IN FISHERIES	2 (1+1)	SEM VII

Objective

To learn to use GIS and Remote sensing to foster the sustainable use of natural fisheries resource.

Theory

Aerial Photography: Basics of photography- terminologies- Photogrammetry – Stereoscopy - Principal points - Parallax and its measurement, Colours - Composite colour images. Remote Sensing - Electromagnetic Spectrum - Radiation laws - Interaction with atmosphere and surfaces, Spectral reflectance of earth materials and vegetation, Satellite Remote Sensing - Resolution - Scanning - Sensors, Land Observation Satellites - Visual image interpretation. Image and Data: Digital image

processing, Image rectification and Image enhancement - Filtering - Band rationing, Image classification - Supervised and unsupervised classification, Remote sensing application in soil andwater conservation. GIS - Types, raster, vector, Database management systems, Data types, Spatial - non-spatial, Spatial data models, Spatial referencing, Map projections, Data input, Editing, Encoding, Raster data analysis, Vector data analysis. Satellite Application: NOAA and IRS Satellites for Ocean and Fisheries studies, Digital image processing and interpretation, Application of remote sensing and GIS to fisheries and aquaculture planning and development. PFZ - Basics and application - Validation of PFZ data- INCOIS- Data Dissemination. Fishermen knowledge in PFZ.

Practical

Study of satellite information, interpretation of satellite pictures for resource management. Case studies on remote sensing and GIS applications. Development of GIS with local parameters related to fisheries. INCOIS data processing and interpretation. Collection and Validation of INCOIS and PFZ data. INCOIS data dissemination methods among coastal fishermen. Survey of effectiveness and usefulness of PFZ data.

Suggested Readings

1. Bhatia B. 2008. Remote Sensing and GIS, Oxford University Press, New Delhi.
2. FAO Technical Manuals on Remote Sensing and GIS in Fisheries and Aquaculture.
3. Josef G. 2005. Fundamentals of Remote Sensing, Universities Press (P) Limited, Hyderabad.
4. Kumar S. 2005. Basics of Remote Sensing and GIS, FirewellMedi, Laxmi Publications, New Delhi.

FE 402	RESPONSIBLE AND SUSTAINABLE FISHING METHODS	2 (1+1)	SEM VII

Objectives

1. To teach various responsible fishing techniques for conservation of biodiversity.
2. To learn various fishing methods and gears for the sustainable exploitation of aquatic resources

Theory

CCRF: Scope and objectives of FAO Code of conduct for Responsible Fisheries, Articles of CCRF – Description of the code, Analysis of marine catch data (present and past); analysisof CCRF concept. Definition of sustainability, Rules and regulations for sustainable fishing, Properties of a sustainable fishery, Present scenario and problems of sustainable fishing, Trends in global and Indian fishery, Environmental defects. By-catch: Elaboration of Article 8 – Fishing operations; By-catch and discards – Definitions, By-catch estimation methods, by-catch reduction devices, turtle excluder devices, Finfish and shrimp excluder devices. Selective fishing gear and practices: Selectivity of trawls, gill nets and lines – Environmentally friendly fishing methods and fishing gears – Energy conservation and resource

enhancement. Fish Aggregation Devices (FADs and Artificial reefs): Objectives, Types of FADs and artificial reefs; Design and construction of FADs and artificial reefs; Energy optimization in fisheries – Methods of energy conservation in fish harvesting. Remote Sensing and PFZ: Application of Remote sensing, PFZ and GIS in fisheries. IUU - Illegal, Unregulated and Unreported fishing methods; Destructive and prohibited fishing systems and practices. Effect of fishing on non-target species. Impacts of unsustainable fishing: Habitat degradation due to bottom trawling, purse seining, Habitat modification, changing the ecosystem balance, Climate change, Ocean pollution, Disease and toxin. Fisheries management, Ecosystem-based fisheries, Marine protected area, Laws and treaties, Conservation methods issues and implications for biodiversity. Remediation for sustainable fishery, Fisheries management, Ecosystem-based fisheries, Marine protected area, Laws and treaties, Awareness campaigns, Sustainable fishing gears and devices, designing of eco-friendly long line, Eco-friendly gillnet, Eco-friendly trawl net, Techniques reducing the risk of unsustainability, Eco-friendly fishing methods and gears.

Practical

Study of design and operation of BRDs and TEDs. Preparation of document listing and prohibited fishing practices. Compilation of package of practices for energy conservation. Designing of eco-friendly fishing devices, square mesh cod end, traps with escape vents, designing of longline with circular hooks. Interpretation of SST and Ocean colour charts. Study of Potential Fishing Zone (PFZ) maps. Problems on fishing gear selectivity. Studies on impact of various fishing gears on the environment and biodiversity.

Suggested Readings

1. CIFNET module III and IV. Code of Conduct for Responsible Fisheries. 61-69pp.
2. FAO. 1995. Code of Conduct for Responsible Fisheries, FAO, Rome, 41p.
3. FAO. 1996. Fishing Operations, FAO Training Guidelines for responsible fisheries No.1, FAO, Rome 26p.
4. FAO. 2003. Fisheries Management. 2. The ecosystem approach to fisheries, FAO
5. Maheswari K. 2011. Sustaining Marine Fisheries. Sonali publication, New Delhi.
6. Michel Kaiser and Groot. Effect of Fishing on Non-target species and Habitats Blackwell publishing.
7. Raval NB. 2013. Combating Marine Pollution. Cyber tech publication, New Delhi.
8. Sinha PC. 2007. Fishing Conservation Management and Development. SBS Publishers and distributers Pvt. Ltd, New Delhi.
9. Technical Guidelines for Responsible Fisheries – No.4, Suppl.2, FAO Rome

FISHERIES EXTENSION, ECONOMICS AND STATISTICS

Course No.	Course Title	Credits	Semester
Core Courses			
FEES 102	Fisheries Entrepreneurship Development and Business Management	3 (2+1)	II
FEES 103	Personality Development	2 (1+1)	II
FEES 201	Fisheries Extension	2 (1+1)	III
FEES 203	Agricultural (Fisheries) Marketing and Trade	3 (2+1)	IV
FEES 301	Fisheries Economics	3 (2+1)	V
FEES 302	Statistical Methods	3 (2+1)	VI
FEES 303	Fisheries Policy and Laws	1 (1+0)	VI
FEES 304	Fisheries Co-operative and Marketing	2 (1+1)	VI
	Total Credits	**19 (12+7)**	
Skill Enhancement Courses			
FEES 101	Start-up and Incubation in Fisheries	2 (0+2)	I
FEES 202	Data Analysis and Computation	2 (0+2)	III
FEES 204	Fish Market Survey and Value Chain Analysis	2 (0+2)	IV
	Total Credits	**6 (0+6)**	
Elective Courses			
FEES 401	Marketing Intelligence and Business Analysis	2 (1+1)	VII
FEES 402	ICT in Fisheries	2 (1+1)	VII
	Total Credits	**4 (2+2)**	
	Grand Total	**29 (14+15)**	

FEES 102	FISHERIES ENTREPRENEURSHIP DEVELOPMENT AND BUSINESS MANAGEMENT	3 (2+1)	SEM II

Objectives

1. To provide students an insight into the concept and scope of entrepreneurship
2. To expose the student to various aspects of the establishment and management of a small business unit
3. To enable the student to develop financially viable agribusiness proposal

Theory

Development of entrepreneurship, motivational factors, social factors, environmental factors, characteristics of entrepreneurs, entrepreneurial attributes/competencies. Concept, need for and importance of entrepreneurial development. Evolution of entrepreneurship, objectives of entrepreneurial activities, types of entrepreneurs, functions of entrepreneurs, importance of entrepreneurial development, and process of entrepreneurship development. Environment scanning and opportunity identification need for scanning–spotting of opportunity-scanning of environment – identification of product/service – starting a project; factors influencing sensing the opportunities. Infrastructure and support systems- good policies, schemes for entrepreneurship development; role of financial institutions, and other agencies in

entrepreneurship development. Steps involved in functioning of an enterprise. Selection of the product/services, selection of form of ownership; registration, selection of site, capital sources, acquisition of manufacturing knowhow, packaging and distribution. Planning of an fish enterprise, project identification, selection, and formulation of project; project report preparation, Enterprise Management. Production management – product, levels of products, product mix, quality control, cost of production, production controls, Material management. Production management – raw material costing, inventory control. Personal management – manpower planning, labour turn over, wages/salaries. Financial management / accounting – funds, fixed capital and working capital, costing and pricing, long-term planning and short-term planning, book-keeping, journal, ledger, subsidiary books, annual financial statement, taxation. Marketing management- market, types, marketing assistance, market strategies. Crisis management- raw material, production, leadership, market, finance, natural etc. Overview of fisheries input industry, Characteristics of Indian fisheries processing and export industry.

Practical

Visit to small scale industries/fisheries-industries, Interaction with successful entrepreneurs/ fisheries-entrepreneurs. Visit to financial institutions and support agencies. Preparation of project proposals for funding by different agencies.

Suggested Readings

1. Charantimath P.M., 2009, Entrepreneurship Development and Small Business Enterprises. Pearson Publications, New Delhi.
2. Desai V., 2015, Entrepreneurship: Development and Management, Himalaya Publl. House.
3. Gupta CB. 2001. Management Theory and Practice. Sultan Chand and Sons.
4. Indu Grover. 2008. Handbook on Empowerment and Entrepreneurship. Agrotech Public Academy.
5. Khanka SS. 1999. Entrepreneurial Development. S. Chand and Co.
6. Mehra P., 2016, Business Communication for Managers. Pearson India, New Delhi.
7. Pandey M. and Tewari D., 2010, The Agribusiness Book. IBDC Publishers, Lucknow.
8. Singh D. 1995. Effective Managerial Leadership. Deep and Deep Publ.
9. Singhal R.K., 2013, Entrepreneurship Development and Management, Katson Books.
10. Tripathi PC and Reddy PN. 1991. Principles of Management. Tata McGraw Hill.
11. Vasant Desai, 1997. Small Scale Industries and Entrepreneurship. Himalaya Publ. House.

FEES 103	PERSONALITY DEVELOPMENT	2 (1+1)	SEM II

Objective

To make students realize their potential strengths, cultivate their inter-personal skills and improve employability

Theory

Personality Definition, Nature of personality, theories of personality and its types. The humanistic approach - Maslow's self-actualization theory, shaping of personality, determinants of personality, Myers-Briggs Typology Indicator, Locus of control and performance, Type A and Type B Behaviours, personality and Organizational Behaviour. Foundations of individual behaviour and factors influencing individual behaviour, Models of individual behaviour, Perception and attributes and factors affecting perception, Attribution theory and case studies on Perception and Attribution. Learning: Meaning and definition, theories and principles of learning, Learning and organizational behaviour, Learning and training, learning feedback. Attitude and values, Intelligence- types of Intelligence, theories of intelligence, measurements of intelligence, factors influencing intelligence, intelligence and Organizational behaviour, emotional intelligence. Motivation- theories and principles, Teamwork and group dynamics.

Practical

MBTI personality analysis, Learning Styles and Strategies, Motivational needs, Firo-B, Interpersonal Communication, Teamwork and team building, Group Dynamics, Win-win game, Conflict Management, Leadership styles, Case studies on Personality and Organizational Behavior.

Suggested Reading

1. Andrews, Sudhir, 1988, How to Succeed at Interviews. 21st (rep.) New Delhi. Tata McGraw-Hill.
2. Heller, Robert, 2002, Effective Leadership. Essential Manager series. Dk Publishing.
3. Hindle, Tim, 2003, Reducing Stress. Essential Manager series. Dk Publishing.
4. Lucas, Stephen, 2001, Art of Public Speaking. New Delhi. Tata - Mc-Graw Hill.
5. Mile, D.J, 2004, Power of Positive Thinking. Delhi. Rohan Book Company.
6. Pravesh Kumar, 2005, All about Self- Motivation. New Delhi. Goodwill Publishing House.
7. Smith, B, 2004, Body Language. Delhi: Rohan Book Company.
8. Shaffer, D. R.,2009, Social and Personality Development. 6th edn. Belmont, CA: Wadsworth.

FEES 201	FISHERIES EXTENSION	2 (1+1)	SEM III

Objectives

1. To help the students to appreciate the process of extension education
2. To cater the need of equipping the scholars with essential skills

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. Fisheries extension methods- individual, group and mass contact methods and their effectiveness, factors influencing their selection and use; characteristics of technology, transfer of technology process.

Important ToT programs in fisheries; role of NGOs and SHGs in fisheries. Fisheries co-management; Adoption and diffusion of innovations, adoption and diffusion process, adopter categories and barriers in the diffusion of fisheries innovations. Extension program planning and evaluation - steps and importance; participatory planning process. Basic concepts in rural sociology and psychology and their relevance in fisheries extension; social change, social control, social problems and conflicts in fisheries; gender issues in fisheries. Theories of learning, learning experience, learning situation.

Practical

Collection of socio-economic data from fishing villages; study of social issues/problems through participatory and rapid rural appraisal techniques. Stakeholders' analysis and needs assessment. Assessment of development needs of community and role of formal and non – governmental organizations through stakeholders' 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.

Suggested Readings

1. Adhikarya R. 1994. Strategic Extension Campaign – A Participatory-Oriented Method of Agricultural Extension.
2. Agarwal B. 1986. Women, Poverty and Agricultural Growth in India, JPS, New Delhi.
3. Antholt C and Zijp W. 1994. Participation in Agricultural Extension. Washington, DC: The World Bank
4. Berdegue JA and Escobar G. 2001. Agricultural Knowledge and Information Systems and Poverty Reduction. AKIS Discussion Paper. Washington, DC: The World Bank.
5. Bhasin K. Understanding Gender, New Delhi, Kali for Women, 2000
6. Birner R and Anderson JR. 2007. How to Make Agricultural Extension Demand Driven–The Case of India's Agricultural Extension Policy. IFPRI Discussion Paper. International Food Policy Research Institute. Washington, DC: IFPRI
7. Daivadeenam P. 2002. Research Methodology in Extension Education. Agro-Tech Publ. Academy.
8. Kerlinger N Fred. 2002. Foundations of Behavioural Research. Surjeet Publ.
9. Menon Nivedita. 1999. Gender and Politics in India, New Delhi: Oxford.
10. Patricia Uberoi. 2009. Freedom and Destiny: Gender, Family, and Popular Culture in India, Oxford University Press, New Delhi
11. Ray GL and Mondal S. 1999. Research Methods in Social Science and Extension Education. NayaProkash.

FEES 203	AGRICULTURAL (FISHERIES) MARKETING AND TRADE	3 (2+1)	SEM IV

Objectives

1. To understand the fundamentals of agricultural (fisheries) marketing and trade
2. To analyze the factors influencing supply and demand in agricultural (fisheries) markets
3. To explore different marketing channels and strategies in fisheries sector
4. To examine the role of government policies and regulations in agricultural (fisheries) markets

Theory

Agricultural (fisheries) Marketing: Concepts and definitions of market, marketing, agricultural (fisheries) marketing, market structure, marketing mix and market segmentation, classification and characteristics of agricultural markets; demand, supply and producer's surplus of agri commodities: nature and determinants of demand and supply of farm products, producer's surplus – meaning and its types, marketable and marketed surplus, factors affecting marketable surplus of agri/fisheries-commodities; pricing and promotion strategies: pricing considerations and approaches – cost based and competition based pricing; market promotion – advertising, personal selling, sales promotion and publicity – meaning, merits and demerits; marketing process and functions: Marketing process concentration, dispersion and equalization; exchange functions – buying and selling; physical functions – storage, transport and processing; facilitating functions – packaging, branding, grading, quality control and labelling (AGMARK); Market functionaries and marketing channels: Types and importance of agencies involved in agricultural marketing; meaning and definition of marketing channel; number of channel levels; marketing channels for different farm products; Integration, efficiency, costs and price spread: Meaning, definition and types of market integration; marketing efficiency; marketing costs, margins and price spread; factors affecting cost of marketing; reasons for higher marketing costs of farm commodities; ways of reducing marketing costs; Role of Government in agricultural marketing: Public sector institutions- CWC, SWC, FCI, CACP and DMI – their objectives and functions; cooperative marketing in India; Risk in marketing: Types of risk in marketing; speculation and hedging; an overview of futures trading; Agricultural (fisheries) prices and policy: Meaning and functions of price; administered prices; need for innovations in agricultural price policy; Trade: Concept of International Trade and its need, theories of absolute and comparative advantage. Present status and prospects of international trade in agri-commodities; WTO; Agreement on Agriculture (AoA) and its implications on Indian agriculture; IPR. Role of government in agricultural marketing. Role of APMC and its relevance in the present-day context, Fisheries Policy and Law.

Practical

Plotting and study of demand and supply curves and calculation of elasticities; Study of relationship between market arrivals and prices of some selected commodities;

Computation of marketable and marketed surplus of important commodities; Study of price behaviour over time for some selected commodities; Construction of index numbers; Visit to a local market to study various marketing functions performed by different agencies, identification of marketing channels for selected commodity, collection of data regarding marketing costs, margins and price spread and presentation of report in the class; Visit to market institutions – MPEDA, NAFED, SWC, CWC, cooperative marketing society, etc. to study their organization and functioning; Application of principles of comparative advantage of international trade.

Suggested Readings

1. Acharya, S.S. and Agarwal, N.L., 2006, Agricultural Marketing in India, Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
2. Chinna, S.S., 2005, Agricultural Economics and Indian Agriculture. Kalyani Pub, N Delhi.
3. Dominic Salvatore, Micro Economic Theory.
4. Kohls Richard, L. and UhlJosheph, N., 2002, Marketing of Agricultural Products, Prentice-Hall of India Private Ltd., New Delhi.
5. Kotler and Armstrong, 2005, Principles of Marketing, Pearson Prentice-Hall.
6. Lekhi, R. K. and Jogindr Singh, 2006, Agricultural Economics. Kalyani Publishers, Delhi.
7. Memoria, C.B., Joshi, R.L. and Mulla, N.I., 2003, Principles and Practice of Marketing in India, Kitab Mahal, New Delhi.
8. Pandey Mukesh and Tewari, Deepali, 2004, Rural and Agricultural Marketing, International Book Distributing Co. Ltd, New Delhi.
9. Sharma, R., 2005, Export Management, LaxmiNarain Agarwal, Agra.

FEES 301	FISHERIES ECONOMICS	3 (2+1)	SEM V

Objectives

To teach economics theories for taking decisions by individual consumers, producers, and also farms.

Theory

Introduction to fisheries economics, basic economic terminologies – micro and macroeconomics, positive and normative economics, environmental economics, resource, scarcity, farm-firm relationships, production contribution of fisheries sector to the economic development of the country.

Micro-Economics: theories of demand, supply; market – equilibrium price, consumption, utility, Consumer surplus. Elasticity – price, income, cross, application of elasticity in fisheries managerial decision. Farm production economics – production functions in capture and culture fisheries; Costs and returns –breakeven analysis of fish production system; concepts of externalities and social cost; factors of production, marginal cost and return, law of diminishing marginal return, returns to scale, economies of scale and scope, revenue, profit maximization, measurement of

technological change, farm planning and budgeting. Significance or importance of marginal cost.

Macro-Economics: Introduction to national income, accounting, measurement and determinants of national income, the contribution of fisheries to GNP and employment; balance of payments, economic growth and sustainable development. Globalization: dimensions and driving forces. Introduction to GATT and WTO. WTO Framework – Key Subjects - Agreement on Sanitary and Phytosanitary Measures (SPS), Seafood Export Regulations; Non-Tariff Barriers (NTBs) and Agreement on Anti-Dumping Procedures. Fisheries Subsidies and WTO. Fisheries Trade and Environment; protests against globalization and WTO. Intellectual Property Rights (IPR) and different forms. Patents and patenting process, Agreement on TRIPS. Bio-piracy. GMOs in fisheries. Salient features of Indian Patent (Amendment) Act 2005. Overview of Patents in Indian fisheries sector.

Practical

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.

Suggested Readings

1. David M Kreps. 1990. A Course in Microeconomic Theory. Princeton University Press
2. Dewitt K.K. 2002. Modern Economic Theory. Sultan Chand and Co.
3. Geetika GP and Choudhury PR. 2011. Managerial Economics (2nd edn). New Delhi: TataMcGra w Hill Education Private Limited.
4. Jhingran ML. 2004. Micro Economic Theory. Vikash Publishing House Pvt. Ltd. New Delhi.
5. Haran J. 2012. Managerial Economics. Jaipur: Garima Publications.
6. Shrivastava OS. 2013. Modern Managerial Economics: Including Micro and Macroeconomics. New Delhi: Anmol Publications Pvt. Ltd.
7. Silberberg E and Suen W. 2001. The Structure of Economics – A Mathematical Analysis

FEES 302	STATISTICAL METHODS	3 (2+1)	SEM VI

Objectives

1. To learn basic statistical methods for research data analysis
2. To teach statistical problems for analysis

Theory

Definition of statistics, Concepts of population, sample, Census and sample surveys. Classification of data, frequency and cumulative frequency table. Diagrammatic and graphical representation of data - bar diagrams, pie-diagram, histogram, frequency

polygon, frequency curve and Ogives. Important measures of central tendency - arithmetic mean, median and mode. Relative merits and demerits of these measures. Important measures of dispersion - Range, Mean Deviation, Variance and Standard Deviation. Relative merits and demerits of these measures. Coefficient of variation; Normal Curve, Concepts of Skewness and kurtosis. Definitions of probability, mutually exclusive and independent events, conditional probability, addition and multiplication theorems. Random variable, concepts of theoretical distribution; Binomial, Poisson and Normal distributions and their use in fisheries. Basic concept of sampling distribution; standard error and central limit theorem. Introduction to statistical inference, general principles of testing of hypothesis, types of errors. Tests of significance based on Normal, t, and Chi-square distributions. Bivariate data, scatter diagram, simple linear correlation, measure and properties, linear regression, equation and fitting; relation between correlation and regression. Length-weight relationship in fishes; applications of linear regression in fisheries. Methodology for estimation of marine fish landings in India, Estimation of inland fish production in India and problems encountered.

Practical

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.

Suggested Readings

1. Barbara Illowsky. et al. 2022. Introductory Statistics. Open Tax Publ.
2. Bruce, P., Bruce, A, and Gedeck. 2020. Practical Statistics for Data Scientists, Shroff/O'Reilly.
3. Das, N. G. 2017. Statistical Methods (vol. 1 and 2), Tata McGraw Hill Education.
4. Gupta, C.B. 2009. An Introduction to Statistical Methods, 23rd edn, Vikas Publishing House.
5. Gupta, S. P. 2021. Statistical Methods, Sultan Chand and Sons.
6. Wasserman, L. 2004. All of Statistics: A Concise Course in Statistical Inference, Springer.

FEES 303	FISHERIES POLICY AND LAWS	1 (1+0)	SEM VI

Objectives

1. To familiarize various fisheries policy and laws of our country
2. To gain in-depth knowledge on the fisheries and aquaculture policies for sustainable development

Theory

Introduction to public administration, principles of organization and management of public enterprise. Central and State responsibilities for fisheries development, organizational set up of fisheries administration at the Centre and state levels. Present

relevance of past fisheries policies and recent policies in fisheries sector. Functions and powers of functionaries of the department of fisheries, corporations and cooperatives. Different central and state-level fisheries institutions. Role of Central and State Government in the regulatory activities of Aquaculture and fisheries. Implementation of community-based resource management plans. Historical review of fisheries development and management in India and world. International agencies/organizations for promotion of fisheries worldwide. Fisheries legislation: Overview of fisheries and aquaculture legislations in India. Indian Fisheries Act, 1897. Environmental legislation; Water Act, Air Act and Environmental (Protection) Act. International environmental legislation and its impact on fisheries.

Suggested Readings

1. Anon. 1998. Maritime Law of India in the International Context. Bhadarkar Publ.
2. Brahtz JFP. 1972. Coastal Zone Management. U.N. International Economic and Social Affairs, New York.
3. Burke William T. 1992. Fisheries regulations under extended jurisdiction and international law: Food and Agricultural Organization of the United Nations.
4. Churchill RR and Lowe AV. 1988. Law of the Sea. Manchester University Press.
5. Dixit 2013. Regulating oceanic fishing: international laws and treaties. Delhi Swastik Publications. 264pp. ISBN: 978-93-81991-04-6
6. Henkin L, Pugh RC and Smit H. 1993. International Law: Cases and Materials. West Publ. Co.
7. Holden M and Garrod D. 1996. The Common Fisheries Policy: Origin, Evaluation and Future. 2nd edn. Fishing News Books Ltd.
8. Kumar, U. Biodiversity Principles and Conservation, Narendra Publishing House Publishers and Distributors.
9. Pandey. 2014. Fisheries governance and legislation in India. Delhi Narendra Publishing House 2014: 182p. ISBN: 978-93-82471-85-1
10. Raval. 2013. Combating Marine Pollution: International Laws and Regulations. New Delhi Cyber Tech Publications 2013: 264p. ISBN: 978-93-5053-150-1
11. Sinha RK. (Ed.). 1996. Marine Resources and Applicable Laws (World Environmental Series – 009). Commonwealth Publ.
12. Verghese C P. 1989. Fishing Regulation in India's Territorial Waters. World Fishing.

FEES 304	FISHERIES CO-OPERATIVE AND MARKETING	2 (1+1)	SEM VI

Objective

To familiarize students with basic concepts and principles of co-operative and marketing with reference to fisheries

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. 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; role of NABARD in fisheries development; role of insurance in fish and shrimp farming and industry. Basic accounting procedures, profit and loss account. 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 behaviour and marketing research. 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; export markets and marketing of fish and fishery products; Trade liberalization in fisheries markets. Integrated marketing approach in fisheries. Sea food export case study on product and market diversification export and import policies (fisheries). New product development and market segmentation. Export and import policies relevant to fisheries sector.

Practical

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.

Suggested Readings

1. ICAR, 2003.Textbook of Agricultural Marketing and Cooperation, ICAR.
2. Krugman PR and Obstfeld M. 1991. International Economics: Theory and Policy. Harper Collins Publ.
3. Mahajan, K.A. 2003, Cooperative Marketing, Anmol Publications Pvt. Limited,
4. Ministry of Agriculture. Handbook of Fisheries Statistics. New Delhi.
5. Porter G. 1998. Fisheries Subsidies – Overfishing and Trade. Geneva.

FEES 101	START-UP AND INCUBATION IN FISHERIES	2 (0+2)	SEM I

Objectives

1. To expose students to the entrepreneurial ecosystem in the fisheries sector
2. To develop practical skills in start-up planning, business modelling, and incubation processes
3. To familiarize students with innovation, funding mechanisms, and networking opportunities in fisheries start-ups

Practical

Visit to a fisheries start-up or incubator (e.g., RKVY-RAFTAAR Agribusiness Incubation Centres), mapping the start-up ecosystem in fisheries (feed, hatchery, processing, marketing), preparation of a lean business canvas model for a fisheries-based start-up, tools and techniques for ideation, problem validation, and solution fit. Interaction with fisheries entrepreneurs, incubator managers, and investors, field study: Identification of gaps in the fisheries value chain for potential enterprise creation, preparation of a minimum viable product (MVP) concept in fisheries (e.g., fish vending solutions, feed formulation unit), understanding incubation support services: funding, mentoring, co-working spaces, case study analysis: success stories and failures in fisheries entrepreneurship, pitching exercise: presentation of a start-up idea in mock incubator setting.

FEES 202	DATA ANALYSIS AND COMPUTATION	2 (0+2)	SEM III

Objectives

1. To train students in basic statistical analysis using fisheries-related data
2. To provide hands-on experience with statistical software and computation tools
3. To develop data interpretation and presentation skills relevant to fisheries research and extension

Practical

Introduction to data types, coding, cleaning, and tabulation in Excel, use of MS Excel and Google Sheets for basic statistical functions (mean, median, mode, SD, CV), frequency distribution and histogram plotting, data visualization: Bar graphs, pie charts, line graphs using fisheries datasets, introduction to statistical software: SPSS/R (Installation, interface, dataset creation), descriptive statistics in SPSS/R: Central tendencies, dispersion, cross-tabulation, t-test and Chi-square analysis using SPSS (application in fisheries data), correlation and regression exercises using fisheries production and market data, data interpretation and result writing for extension bulletins/reports, preparation of infographics and dashboards for fisheries communication.

FEES 204	FISH MARKET SURVEY AND VALUE CHAIN ANALYSIS	2 (0+2)	SEM IV

Objectives

1. To provide hands-on training in fish market data collection, analysis, and interpretation
2. To understand the structure, dynamics, and stakeholders of fisheries value chains
3. To develop skills in value chain mapping, actor analysis, and policy implication assessment

Practical

Conducting a rapid market appraisal (RMA) at wholesale and retail fish markets, design and administration of structured questionnaires for value chain actors,

mapping of fisheries value chains: Input suppliers, producers, intermediaries, processors, retailers, value addition practices in fisheries: Handling, icing, packaging, marketing techniques, identification of constraints and opportunities at different nodes of the chain, cost–benefit analysis at each value chain level using real market data, gender roles and socio-economic dynamics in fish marketing systems, SWOT analysis of traditional vs. modern fish marketing channels, field visits to fish markets, processing centres, and cold chain units, report writing and presentation of a complete value chain analysis of one fish species (e.g., Rohu, Shrimp, Catla).

FEES 401	MARKETING INTELLIGENCE AND BUSINESS ANALYSIS	2 (1+1)	SEM VII

Objective

To give an idea about the marketing intelligence and business analysis applied in the fisheries sector

Theory

Research methodology: The role of marketing intelligence in the firm, The process of marketing research, The difference between exploratory and confirmatory research, Secondary and primary data, Qualitative and quantitative research methodologies, Sampling theory. Requirements in business analysis: Management, Communication, Tracing, Configuration and change management, quality assurance, Development, Elicitation including stakeholders and/or product requirements development, Specification. Business analytics: Business Analysis, Internal analysis, External analysis, Business need definition, Gap analysis, Solution proposal (including feasibility analysis), Solution delivery or maintenance program/project initiation - Business process definition, Business goals, Business needs, Business requirements, Limitations and assumptions. Modelling and forecasting: Solution modelling, validation and verification,Solution evaluation and optimization, Assessing the solution options (proposals), Evaluating performance of the solution, Solution/business process optimization, Model Volatility with ARCH and GARCH for Time Series Forecasting. Marketing research: Definitions of the various methodological concepts -Various steps involved in designing a research plan, Data collection methods; Characteristics, Structure, Sources, Value, and use of Big Data. The relationship between digital analytics and inbound marketing strategies, Consumer information and measurement services, Rules for designing a questionnaire. Data analysis in marketing research: Data sources for assessing consumer preferences, firm performance, and market condition and competition analyze enterprise data, especially for purposes of segmentation, targeting, positioning, and evaluating consumer value- process of organizing, writing, framing, and refining analytics reports- delivering effective presentations, and aligning analytic results with stakeholder needs and preferences.

Practical

Marketing Research – ethics, standards and issues. Utilization of Secondary Data Resources for Customer Segmentation Pricing and Elasticity. Linear Regression,

Basics; Using Linear Regression to Forecast. Conjoint Analysis; Digital Marketing Metrics Customer Lifetime Value; Cluster Analysis. Finding and interpreting secondary data. Suggesting a methodology for fisheries marketing research. Tools and concepts of data visualization.

Suggested Readings

1. Carlson C.C., Wilmot, W.W. Innovation: The Five Disciplines for Creating What Customers Want, New York: Crown Business, 2006, ISBN: 0307336697 Edition, ISBN 13: 978-0-13-608543-0
2. eNAM – National Agricultural Market https://enam.gov.in
3. Harrington H. James. 1991. Business Process Improvement: The Breakthrough Strategy for Total Quality, Productivity, and Competitiveness. Inspires Innovation, HarperCollins, 2009, ISBN 978-0061766084
4. Malhotra, Naresh. Marketing Research: An Applied Orientation, Sixth
5. MPEDA – Marine Products Export Development Agency – mpeda.gov.in
6. NFDB- National Fisheries Development Board – nfdb.gov.in.
7. Pearson Prentice Hall Analyzing the Target Market, Part 1: Chapter 3, Marketing Research, Harvard Business Publishing BEP 117, length 18 pages.

FEES 402	ICT IN FISHERIES	2 (1+1)	SEM VII

Objective

To orient students on advances in ICT initiatives, knowledge management process smart/disruptive technologies and data analytics

Theory

ICTs – meaning, concepts, roles and initiatives, basics of ICTs, Global and National status, Types and functions of ICTs, Meaning of e-Governance, e-learning, m-Learning, Advantages andLimitations of ICTs. Knowledge management: Meaning, Approaches and Tools, Role of ICTs in Agricultural Knowledge Management, e-Extension, overview on Global and national e-Extension initiatives, Inventory of e-Extension initiatives in Agriculture and allied sectors from Central and State governments, ICAR, SAUs, private sector and NGOs in India**.** ICT applications: Knowledge centres (tele centres), CSC, Digital kiosks, Web portals, Community radio, Internet radio, Kisan call centres, Mobile based applications, INCOIS-PFZ advisories; Self-learning CDs on Package of practices, Augmented Learning, Virtual Learning, social media, Market Intelligence and Information Systems-e-NAM, Agmarknet, etc. Expert System/ Decision Support System/Management Information Systems, Farm Health Management and Intelligence System for Plant/Animal/Soil Health, Fishery, Water, Weather, etc., National e-Governance Plan in Agriculture (NeGP-A). Networks and policies: Global and regional knowledge networks, international information management systems, e-Learning platforms (MOOCS, Coursera, EduEx, etc.); Digital networks among extension personnel, Farmer Producers Organisations (FPOs) / SHGs/ Farmers Groups, Video conference, Live streaming and Webinars, types and functions of social media applications, Guidelines for preparing social media content, Engaging audience, Data analytics and Info graphics. Smart technologies for extension: Open technology computing facilities,

System for data analytics/ mining/ modelling/ Development of Agricultural simulations; Remote Sensing, GIS, GPS, Information Utility (AIU). Disruptive technologies Analysis; Internet of Things (IoTs), Drones, Artificial intelligence (AI), Blockchain technology, social media and Big Data analytics for extension.

Practical

Content and client engagement analysis. Case studies and exercises on ICT-based interventions in fisheries and agriculture. Designing extension content for ICTs; Creating and designing web portals, blogs, social media pages. Development and use of online and offline e-learning modules in fisheries. Live streaming extension programs and organizing webinars. Visit to KCC; Exercises on developing mobile-based applications. Developing social media pages for disseminating fisheries related information. Writing for digital media. Developing video content related to fisheries. Conducting exercise on remote sensing and GIS.

Suggested Readings

1. August E Grant and Jennifer H. Meadows (Ed.). 2012. Communication Technology Update and Fundamentals, Focal Press, USA.
2. Batcheloret et al. 2003. ICT for Development: Contributing to the Millennium Development Goals: Lessons Learned from Seventeen ICT Development Projects, World Bank.
3. Donner J and Parikh T. (eds). 2013. ICTD2013. Proceedings of the Sixth International Conference on Information and Communication Technologies and Development held in Cape Town, South Africa.
4. Elder L, Emdon H, Fuchs R and Petrazzini B. (eds). 2013. Connecting ICTs to Development, Anthem Press, London.
5. ICTs for Development (http://ict4dblog.wordpress.com/).

FISH PROCESSING TECHNOLOGY

Course No.	Course Title	Credits	Semester
Core Courses			
FPT 201	Fundamental of Biochemistry and Food Chemistry	3 (2+1)	III
FPT 202	Post-Harvest Handling and Preservation	2 (1+1)	III
FPT 205	Fish Products, By-Products, Value Addition and Waste Management	3 (2+1)	IV
FPT 301	Fish Freezing Technology	2 (1+1)	V
FPT 302	Fish Canning Technology and Packaging	2 (1+1)	V
FPT 303	Microbiology of Fish and Fisheries Products	2 (1+1)	VI
	Total Credits	**14 (8+6)**	
Skill Enhancement Courses			
FPT 203	Bio-chemical Analysis of Fish and Fisheries Products	2 (0+2)	III
FPT 204	Fish Handling, Transportation and Preservation	2 (0+2)	III
FPT 206	Preparation of Fish By-Products and Waste Utilization	2 (0+2)	IV
FPT 207	Preparation and Marketing of Value-Added Products	2 (0+2)	IV
	Total Credits	**8 (0+8)**	
Elective Courses			
FPT 401	Quality Assurance of Fish and Fishery Products	3 (2+1)	VII
FPT 402	Principles and Techniques of Seafood Analysis	2 (1+1)	VII
FPT 403	Trade Regulations, Certification and Documentation in Export of Fish and Fishery Products	2 (1+1)	VII
	Total Credits	**7 (4+3)**	
	Grand Total	**29 (12+17)**	

FPT 201	FUNDAMENTAL OF BIOCHEMISTRY AND FOOD CHEMISTRY	3 (2+1)	SEM III

Objectives

1. To create basic understanding on biochemical constituents of food fish and shellfish
2. To develop skills on the analysis of chemical constituents in food

Theory

A brief introduction to developments in biochemistry and its transformation to molecular biology. Cell structure, water and major molecules of life. Composition of food and nutritional value. Moisture in foods. Biological oxidation, electron transport chain, P/0 ratio; oxidative phosphorylation. Carbohydrates: Structure, classification and functions of carbohydrate. Isomerism and mutarotation. Metabolism of

carbohydrates: Glycolysis, gluconeogenesis, glycogenolysis, glycogenesis, TCA cycle, central role of TCA cycle in metabolism. Naturally occurring polysaccharides in foods. Seaweed polysaccharides – sources and uses. Browning reactions – enzymatic and non-enzymatic.

Lipids: Classification, structure, functions and properties of lipids. Essential fatty acids and phospholipids. Metabolism of lipids, oxidation of fatty acids, lipoproteins; VLDL and HDL and their importance. Lipid autooxidation. Significance of Omega-3 and Omega-6 fatty acids.

Proteins: Classification, structure, function and properties of proteins. Essential and nonessential amino acids. Biuret reaction and xanthoproteic reaction of protein detection. 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. Texturized proteins.

Enzymes: Nomenclature; classification; specificity; mechanism of enzyme action; kinetics and regulation of enzyme activity. Steroid and peptide hormones: Chemistry and function. Vitamins and Minerals: Classification and functions. Structure and functions of fat and water-soluble vitamins. Minerals: Classification and functions minerals. Nucleic acids: Structure and function. Importance of genetic code.

Chemistry of taste, flavour and odour components in foods, flavour intensifiers, synthetic flavouring substances. The taste of fish and shellfish. Food additives - types and their chemical nature, emulsifiers and antimicrobial additives, sequestrants, flavour potentiators surface active agents; non-nutritive sweeteners, colour additives in food. Assessment of quality of food by instrumental and chemical methods. Nutritive value of foods. Energy value and energy requirements and their estimation. Water, electrolytic and acid-base balance. Nutritive value of proteins PER, BV digestibility coefficient, NPU values, pepsin digestibility. Role of fibre in human nutrition.

Practical

Preparation of normal solution of acid and base, buffers and reagents. Estimation of moisture, crude protein, fat, ash (including acid soluble) in fish sample. Estimation of carbohydrates in foods. Determination of energy value of fish. Estimation of glucose and salt content in foods. Colorimetric method of estimation of proteins and carbohydrates. Estimation of freshness quality indices such as TVBN, TMA, alpha-amino nitrogen, PV, FFA, TBA value of fish. Estimation of fibre in foods. Determination of specific gravity of oil. Determination of saponification value, iodine value and free fatty acid value.

Suggested Readings

1. Ashrust PR. 1999. Food Flavourings. 3rd edn. Aspen Publ.
2. Belitz HD and Grosch W. 1999. Food Chemistry. 2nd Ed. Springer.
3. Berg JM, Tymoczko JL and Stryer L. 2002. Biochemistry. W.H. Freeman and Company.

4. H A Modi. 2012. Food additives. Aavishkar Publishers Distributors (Jaipur)
5. Hutching JB. 1999. Food Colour and Appearance. 2nd Ed. Aspen Publ.
6. Keith Wilson, John Walker, 2013. Principles and Techniques of Biochemistry and Molecular Biology, Cambridge University Press (New York).
7. Michael J. Scotter. 2015. Colour Additives for Foods and Beverage. Woodhead Publishing Limited (Oxford).
8. Murray RK, Granner DK, Mayes PA and Rodwell VW. 2000. Harper's Biochemistry. Appleton and Lange
9. NIIR Board. Food colours, flavours and additives technology hand book. National Institute of Industrial Research (Delhi).
10. Samantaray, K. Principles of Biochemistry (with special reference to fishes). Narendra Publishing House
11. SemihOtles. 2012. Methods of Analysis of Food Components and Additives. CRC Press (Boca Raton).
12. Teranishi R, Buttery RG and Shahidi F. 1989. Flavour Chemistry – Trends and Developments. American Chemical Society, Washington D.C
13. Voet D, Voet JG and Pratt CW. 2006. Fundamentals of Biochemistry. John Wiley and Sons, Inc
14. Wilson K and Walker J. 1995. Principles and Techniques of Practical Biochemistry. Cambridge University Press.

FPT 202	POST-HARVEST HANDLING AND PRESERVATION	2 (1+1)	SEM III

Objectives

1. To teach scientific techniques of handling, storage and transport of fresh fish
2. To teach various post-harvest changes during chill storage of fish

Theory

Structure of fish myosystems, Postmortem changes - Structural and chemical. Fish as raw material for processing: Body structure, physical properties, shape, specific weight, bulk weight, angle of slip, weight composition. Factors affecting quality of fresh fish: intrinsic and extrinsic factors. Handling of fish onboard fishing vessels, Unit operations. Unloading fish, Fish pumps. Post-harvest Fishery losses, Methods to reduce losses. Handling of fish in landing centres, defects and modifications needed. Chill storage of fish: Heat load calculation, storage methods. Insulated boxes and insulation thickness, different types of ice, physical, chemical, microbiological and sensory changes during chill storage, iced storage shelf life, cold shock, physical, chemical and sensory methods of analysis. Different types of ice and their advantages. Melanosis and its prevention, discolouration in aquatic products, nonenzymatic browning. Depuration of bivalves. Transportation: Live fish/shellfish, Transportation of raw fish to local markets and processing centres, Improvements needed in transportation, Refrigerated transport systems. Classification of transport vehicles. Cold chain.

Practical

Chill storage studies: Chemical, physical and sensory analysis, determination of shelf life. Handling of fish, bivalves, prawns, molluscs, Depuration, treatment with chemicals, evaluation of freshness of fish.

Suggested Readings

1. Aitken A, Mackie M, Merritt SH & and Windsor ML. 1982. Fish Handling and Processing.
2. Anon. 1965. Fish Handling and Preservation. Proc. Meeting on Fish Technology.,
3. Balachandran KK. 2001. Post Harvest Technology of Fish and Fish Products. Daya Publ.
4. Connell JJ. 1980. Advances in Fish Sciences and Technology. Farnhan Surrey.
5. George MH. 1992. Fish Processing Technology. VCH Publ.
6. Gopakumar K. (Ed.). 2002. Text Book of Fish Processing Technology. ICAR.
7. Ministry of Agriculture, Fisheries and Food, Edinburgh.
8. Scheveningen. Organisation for Economic Co-operation and Development, Paris.
9. Sen DP. 2005. Advances in Fish Processing Technology. Allied Publ.

FPT 205	FISH PRODUCTS, BY-PRODUCTS, VALUE ADDITION AND WASTE MANAGEMENT	3 (2+1)	SEM IV

Objectives

1. To understand the concepts of fish products and by-products
2. To teach concepts of value addition of fish products and waste management

Theory

Principle of fish preservation and processing. Processing of fish by traditional methods–salting, sun drying, smoking, marinading and fermentation. Theory of salting, methods of salting–wet salting and dry salting. Drying and dehydration-theory, importance of water activity in relation to microbial growth. Sun drying and artificial drying- solar dryer. Packaging and storage of salted and dried fish. Different types of spoilage in salt-cured fish. Quality standard for salted and dry fish.Fish preservation by smoking-chemical composition of wood smoke and their role in preservation. Methods of smoking and equipment used for smoking. Carcinogenic compound in wood and methods to remove them. Hurdle technology in fish preservation and processing. Marinated and fermented fish products–role of acids in marinades, Fish and prawn pickles, fish sauce and Fish paste, traditional Indian fermented products. Principles and methods of preparation of various fish paste products like fish sausage, fish ham, surimi, fish cake, kamaboko etc. Fish muscle structure, myofibrillar protein and their role in elasticity formation. Extruded products: theory of extrusion, equipment used, advantages of extruded products, methods of preparation of extruded products. Value addition. Diversified fish products: battered and braided products-fish finger, fish cutlet, fish wafer, and fish soup powder etc. and imitation products. HACCP in safe product production. Fish meal: dry reduction and wet reduction methods, specification, packaging and storage. Fish oil: body oil, liver oil extraction, purification, preservation, storage, and

application. Shrimp wastes: chitin, chitosan production, uses. Fish protein concentrate. Fish hydrolysate, partially hydrolysed and deodorized fish meat, functional fish protein concentrate and their incorporation to various products. Fish silage, acid silage, fermented silage and their application. Fish maws, shark leather, fish glue, fish gelatine, isinglass, pearl essence, shark fin rays, beach-de-mer. Biochemical and pharmaceutical products. Utilization of seaweeds: agar agar, algin, carrageenan.

Practical

Preparation of salted fish, dried fish and smoked fish by different methods. Quality assessment of salted, dried and smoked fish. Preparation of prawn and fish pickles. Preparation of fermented fish sauce and marinade 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.

Preparation of fish meal, fish body oil, fish liver oil, fish maws, isinglass, fish silage, ensilage, fish glue, fish gelatine, fattice, pearl essence, chitin, chitosan and fish manure. Preparation of acid and fermented silage. Preparation of fish protein concentrate and fish hydrolysate.

Suggested Readings

1. Balachandran KK. 2001. Post-Harvest Technology of Fish and Fish Products. Daya Publ.
2. Elvevoll EO. Fish Waste and Functional foods, Norwegian College of Fishery Science, Department of Marine Biotechnology, Norway. edele@nfh.uit.no
3. FereidoonShahidi. 2007. Maximizing the Value of Marine By-Products, CRC Press Inc. (Florida)
4. Gopakumar K. (Ed.). 2002. Text Book of Fish Processing Technology. ICAR.
5. Hall GM. (Ed.). 1992. Fish Processing Technology. Blackie.
6. Nambudiri DD. 2006. Technology of Fishery Products. Fishing Chimes.
7. Sen DP. 2005. Advances in Fish Processing Technology. Allied Publ.
8. T Borresen 2008, Improving Seafood Products for the Consumer, Woodhead Publishing Limited (Cambridge)
9. Venugopal V. 2005. Seafood Processing: Adding Value Through Quick Freezing Retort Packaging, and Cook-Chilling, Taylor and Francis (Boca Raton).
10. Wheaton FW and Lawson TB. 1985. Processing Aquatic Food Products. John Wiley and Sons.

FPT 301	FISH FREEZING TECHNOLOGY	2 (1+1)	SEM V

Objectives

1. To gain knowledge on the mechanism of action of chilling and freezing methods for preservation of fish and shellfish
2. To understand the mechanism of the freezing technology for preservation

Theory

Introduction to freezing technology; characteristics of fish and shellfish. Changes in fish after death, spoilage of fish, spoilage and pathogenic microorganism. Handling of fresh fish; sanitation in processing plants. 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; use of antibiotics and chemicals. 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 and shellfish for freezing. 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 and shellfish: methods of thawing. Transportation of frozen fish and shellfish, cold chain, quality control, HACCP in freezing industry.

Practical

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 Readings

1. AOAC manual
2. Balachandran KK. 2001. Post-harvest Technology of Fish and Fish Products. Daya Publ. House.
3. Clucas IJ. 1981. Fish Handling, Preservation and Processing in the Tropics. Parts I, II. FAO.
4. Gopakumar K. (Ed.). 2002. Text Book of Fish Processing Technology. ICAR.
5. SEAFDEC manual
6. NalanGokoglu, Pinar Yerlikaya. 2015. Seafood Chilling, Refrigeration and Freezing: Science and Technology, John Wiley and Sons (Chichester)
7. Sen DP. 2005. Advances in Fish Processing Technology. Allied Publ.
8. Venugopal V. 2006. Seafood Processing. Taylor and Francis.

FPT 302	FISH CANNING TECHNOLOGY AND PACKAGING	2 (1+1)	SEM V

Objectives

1. To provide information on various aspects of thermal / heat processing, fish packaging materials, their appropriate use and benefits
2. To impart knowledge on canning technology, packaging and labelling

Theory

Fish Canning Technology: Introduction to canning and its historical developments. Advantages of canning in relation to other preservation methods. Raw materials, their characteristics and suitability for canning. Classification of foods based on pH, commercial sterility, absolute sterility, pasteurization and sterilization. Canning

process: Process flow steps involved HTST and aseptic canning. General steps in canning procedure and importance, preparation of raw material, packing, pre-cooking, exhausting, seaming, retorting, cooling labelling and storage. Principles of thermal processing. Heat resistance of microorganisms, heat penetration studies, mechanism of heat transfer. 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). Commercial sterilization, 12-D concept. Canning of commercially important fin fishes, shellfishes and cephalopods. Spoilage of canned foods, types, causes and preventive measures. Quality standards, plant layout, hygiene and sanitation and waste disposal.

Packaging: Introduction to packaging, Importance of packaging in fish processing, functions, objectives and requirements. Packaging materials, basic and laminates, principles of their manufacture and their identification. Properties of packaging materials and their use; Protective packaging with special reference to food. Printing for packaging and print identification. 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. Package design, evaluation and testing. Flexible packaging materials, rigid containers, thermoform containers, glass containers, corrugated fibre boards, duplex cartons, edible packaging materials. Laminations and co-extrusions. Retort pouch packaging - advantages and disadvantages. Biodegradable films, vacuum packaging, active packaging, Modified Atmosphere Packaging (MAP). Polymeric Packaging. Packaging requirements of fresh fish, frozen fish, canned fish. Transport worthiness of packaging materials, accelerated shelf testing. Safety and legislation aspects of packaging. Labelling and bar coding.

Practical

Types of cans, canning equipment and layout of cannery. Canning of different varieties of fish and shellfish. Cutout test of canned products. Examination of can double 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.

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 Readings

1. AkhilMathur. 2012. Food Processing, Packaging, Labelling and Marketing. Anmol Publications Pvt. Ltd. (New Delhi)
2. Da-Wen Sun 2005, Thermal Food Processing: New Technologies and Quality Issues, Taylor and Francis (Boca Raton)

3. Gopakumar K. 1993. Fish Packaging Technology - Materials and Methods. Concept Publ.
4. Gordon L Robertson. 2005. Food Packaging: Principles and Practices, "Marcel Dekker, Inc." (New York)
5. Hall GM. (Ed). 1992. Fish Processing Technology. Blackie.
6. Hersom AC and Hulland ED. 1980. Canned Foods. Chemical Publ. Co.
7. Jerry D'Souza, Jatin Pradhan. 2010. Handbook of Food Processing Packaging and Labeling, SBS Publishers and Distributors Pvt. Ltd. (New Delhi)
8. Larousse J and Brown BE. 1997. Food Canning Technology. Wiley VCH.
9. Ponnuswami V. 2012. Nano Food Packaging: A New Post-Harvest Venture, Narendra Publishing House (Delhi)
10. Srinivasa Gopal, TK. 2007. Seafood Packaging, Central Institute of Fisheries Technology (Cochin).
11. Subasinghe S. 1999. Retail Packaging of Fish and Fishery Products, Info Fish.
12. Venugopal V. 2006. Seafood Processing. Taylor and Francis.
13. Warne D. 1988. Manual on Fish Canning. FAO Fisheries Tech. Paper 285.
14. Zeathen P. 1984. Thermal Processing and Quality of Foods. Elsevier.
15. Holdsworth SD. 1997. Thermal Processing of Packaged Foods, Blackie Academic and Professional.

FPT 303	MICROBIOLOGY OF FISH AND FISHERIES PRODUCTS	2 (1+1)	SEM VI

Objectives

1. To teach nature and activity of microbes in fish and fishery products, microbiological spoilage and preservation.
2. To teach in detail about food-borne microorganisms of human health significance, food-borne diseases and their prevention.

Theory

Introduction and history of microorganisms in foods. Role and significance of microorganisms in nature and in foods. Sources and types of microorganisms in fish and fishery products. Factors (intrinsic and extrinsic) affecting the growth and survival of microorganisms in food. Enumeration of microorganisms in food by conventional and rapid techniques. Microbial principles of fish preservation and processing by application of low temperature, high temperature, drying, irradiation and chemicals. Microbiology and spoilage of fresh, semi-processed, and processed fish and fishery products. Indicators of microbiological quality of fish and fishery products. 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. Other biological hazards associated with fish and fishery products-marine toxins shellfish toxins, scombroid toxins, ciguatera toxins and puffer fish toxins; mycotoxins, parasites and viruses.

Practical

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, Listeria monocytogenes* 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 Readings

1. Anon. 2001. Food Borne Disease Handbook. 2nd edn. Vol. IV. Seafood and Environmental Toxins. Marcel Dekker.
2. Baveja, C. P. 2022. Text Book Microbiology. Arya Publishing Comp.
3. Chakraborthy P. 1995. A Text Book of Microbiology. New Central Book Agency.
4. Criusted J. 1986. Methods in Microbiology. Academic Press.
5. Doyle MP, Beuchat LR and Montville TJ. 1997. Food Microbiology - Fundamentals and Frontiers. American Society for Microbiology.
6. KR Aneja. 2008. Textbook of basic and applied microbiology, New Age International (P) Limited, Publishers (New Delhi).
7. Maheshwaii, D. K. 1999. A Text Book of Microbiology. S. Chand Publishing.
8. Michael J, Pelizar JR and Chan ECS. 1998. Microbiology. McGraw Hill.
9. Rita Narayanan 2013. Food Microbiology: basic and applied with laboratory exercises, New India Publishing Agency (New Delhi).
10. Roberts D, Hooper W, Greenwood M. 1995. Practical Food Microbiology: Methods for the Examination of Food for Micro-organisms of Public Health Significance, Public Health Laboratory Service (London).
11. Thomas J Montville, Karl R Matthews, and Kalmia E. Kniel. Food Microbiology: An Introduction, Third Edition. ASM Press.
12. William CF and Dennis CW. 2000. Food Microbiology. McGraw Hill

FPT 203	BIO-CHEMICAL ANALYSIS OF FISH AND FISHERIES PRODUCTS	2 (0+2)	SEM III

Objectives

1. To train students in estimating proximate composition and energy value of fish and fisheries products
2. To enable students to assess fish freshness using standard biochemical indicators

Practical

Preparation of normal solution of acid and base, buffers and reagents, Estimation of moisture, crude protein, fat, ash (including acid soluble) in Fish and fisheries products. Determination of energy value of Fish and fisheries products. Colorimetric method of estimation of proteins. Estimation of freshness quality indices such as TVBN, TMA, alpha-amino nitrogen, PV, FFA, TBA value of fish. Estimation of fibre in foods.

FPT 204	FISH HANDLING, TRANSPORTATION AND PRESERVATION	2 (0+2)	SEM III

Objectives

1. To provide practical knowledge on handling and transportation of fish and shellfish
2. To teach preservation techniques and methods for evaluating fish quality during storage

Practical

Fish Transportation Methods, Chill storage studies: Chemical, physical and sensory analysis, determination of shelf life. Handling of fish, bivalves, prawns, molluscs, Depuration, treatment with chemicals, evaluation of freshness of fish. Icing Techniques, Traditional and Modern Preservation Techniques, Freezing techniques, Quality changes during freezing storage.

FPT 206	PREPARATION OF FISH BY-PRODUCTS AND WASTE UTILIZATION	2 (0+2)	SEM IV

Objectives

1. To impart skills in preparing value-added fish and fishery products
2. To introduce product diversification and marketing aspects of processed fish products

Practical

Preparation of salted fish, dried fish and smoked fish by different methods. Preparation of surimi and surimi-based products. Preparation of diversified and value-added fish products. Preparation of analog products from surimi, battered and breaded products.

FPT 207	PREPARATION AND MARKETING OF VALUE-ADDED PRODUCTS	2 (0+2)	SEM IV

Objectives

1. To train students in the preparation of fish by-products from processing waste
2. To develop capacity for creating value-added products from fish waste

Practical

Preparation of various fish-derived products and byproducts, including fish meal, fish body oil, fish liver oil, fish maws, isinglass, fish silage and ensilage, fish glue, fish gelatin, fattice, pearl essence, chitin, chitosan, and fish manure. It also covers the processes for the preparation of value-added protein products such as fish protein.

FPT 401	QUALITY ASSURANCE OF FISH AND FISHERY PRODUCTS	3 (2+1)	SEM VII

Objective

To familiarize students with different aspects of quality management systems and evaluation techniques for seafood

Theory

Quality dimensions of seafood – sensory, intrinsic, quantitative and affective parameters. Preharvest and post-harvest factors affecting quality. Assessment of quality changes in fresh and iced fish. Quality changes during processing. Importance of quality, definitions and terminologies. Application of HACCP concept in surveillance and quality assurance program for raw, frozen, canned, cured, irradiated, cooked and chilled, modified atmosphere packaged and freeze-dried products. Risk assessment, principles of plant hygiene and sanitation, pest control, personnel hygiene, planning and layout, equipment construction and design. Food laws and standards, national and international legislation, mandatory and non-mandatory standards. Role of export inspection council and export inspection agency and MPEDA in fish and fishery products. Executive instructions on fish and fishery products, Legislation for export quality assurance in India. Certification system for fish and fishery products. Legal basis for monitoring products related EU requirements. Scheme for approval and monitoring of establishments/factory vessels/ freezer vessels processing/storing fish and fishery products for export. Complaint handling procedure on fish and fishery products. Interpretation of test reports and limits on chemical residues. GOI notifications on fish and fishery products. General requirements for export of fish and fishery products to the EU. International regulatory framework for fish safety and quality. 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. EU legislation on traceability of fish and fish products. Assessment of food safety program, The HACCP for seafood industries and protection of food from adulterants. Standards for sea foods. FSSAI, FDA, ISO. Use of additives in seafood processing as quality enhancers. Seafood safety, authenticity, traceability. Waste management in seafood processing.

Practical

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 Readings

1. Alasalvar C, Miyashita K, Shahidi F, and Wanasundara U. 2011. Handbook of Seafood Quality, Safety and Health Applications. Wiley-Blackwell (Oxford).

2. Huss. 2007. Assessment and Management of Seafood Safety and Quality. Daya Publishing House (Delhi)
3. Kanduri L and Eckhartt RA. 2002. Food Safety in Shrimp Processing. Fishing News Books.
4. Kreuzer R. 1971. Fish Inspection and Quality Control. Fishing News Books.
5. Shukla RK. 2006. Total Quality Management Practicing Manager. New Royal Book.

FPT 402	PRINCIPLES AND TECHNIQUES OF SEAFOOD ANALYSIS	2 (1+1)	SEM VII

Objective

To provide knowledge on various instrumental techniques in seafood analysis

Theory

Separation of molecules: General principles of separation of micro and macro-molecules, Selection of appropriate tools for analysis of fish samples, Outlines of common techniques involved in biochemical analysis. Filtration and centrifugation techniques: Different types of filtrations, Types of filters and means of using them; Types of centrifugations (preparative and analytical), concept of Svedberg unit, Selecting appropriate rotor, Relative centrifugal force. Viscoelastic properties, Rheology, Tribology, TPA; IR and FTIR spectrophotometry, Spectro-fluorimetry, ICP, Atomic absorption mass spectrometry, Tandem MS/MS. Microscopy: Fluorescence microscopy, SEM, TEM, XRD. Electrophoresis: General principles, types (native, denatured PAGE, 2D). Chromatographic techniques; General principle, Types of chromatography: adsorption, partition, ion-exchange, molecular sieve, affinity, liquid and gas chromatography (GC), thin layer chromatography, HPLC, GCMS, LCMSMS.

Practical

Characterization of proteins based on solubility: sarcoplasmic, myofibrillar, and stroma; Estimation of proteins - Biuret techniques, Lowry techniques, Dye binding technique and electrophoretic techniques. Amino acid analysis by HPLC. Fatty acid analysis by GC MS, Minerals and heavy metals by Atomic Absorption spectroscopy. Texture analysis by TPA. HPLC- determination of histamine. Demonstration of GC-MS-MS.

Suggested Readings

1. Ewing GW. 1997. Analytical Instrumentation Handbook. Marcel Dekker.
2. Lakshmanan. 2010. Modern Analytical Techniques Central Institute of Fisheries Technology (Cochin).
3. Leo ML, Nollet and Fidel Toldra. 2010. Handbook of Seafood and Seafood Products Analysis CRC Press Inc. (Florida)
4. Otles S. 2016. Handbook of Food Analysis Instruments. CRC Press.
5. Pare JRJ and Belanger JMR. 1997. Instrumental Methods in Food Analysis. Elsevier.

6. Robyt JF and White BJ. 1990. Biochemical Techniques - Theory and Practice. Waveland Press.
7. Wilson K and Walker J. 2000. Practical Biochemistry - Principles and Techniques. Cambridge University Press.
8. Wilson RH. 1994. Spectroscopic Techniques for Food Analysis. VCH Publ.

FPT 403	TRADE REGULATIONS, CERTIFICATION AND DOCUMENTATION IN EXPORT OF FISH AND FISHERY PRODUCTS	2 (1+1)	SEM VII

Objective

To create basic understanding about Trade Regulations, Certification and documentation in export of fish and fishery products.

Theory

Trade policy and Legislation on labelling and other standards: Foreign Trade Policy of Fish and Fishery Products in Indian context and world context, labelling requirements of Fish and Fishery products stipulated by National and International Organizations. Regulations: Export documentation- certificates of origin. Other certificates for Shipment of specific goods, Export licenses; Import regulations, SPS-TBT agreement. Export Certification systems: Consignment-wise, in process Quality, Self-Certification, Food safety management system, Pre-shipment inspection, Voluntary food certification scheme, Certificate for export (CFE), Health certificate. Other certification, Traceability issues for farm reared and wild aquatic products; Dealing with returned consignments; foreign trade regulations in India.

Practical

Documentation protocol for approval of fishing vessel, processing unit and technologist in processing plants. Labelling codes for Traceability of products in Export trade. Preparation of BOL and LC. Preparation of documents for seafood export to different destinations. Study of documents on customs and port procedures for seafood export and import.

Suggested Readings

1. Batra GS and Kaur Narinder. 1995. Foreign Trade and Export Policy, Anmol Publications Pvt Ltd.
2. Cherian Jacob. 1997. Export Marketing, Himalaya Publishing House.
3. EIC, Export of Fresh, Frozen and Processed Fish and Fishery Products A Guide for Exporters, Export Inspection Council
4. Mittal AC. 1991. Export Management in India. Om Sons. Publications.
5. RathoreKumkum. 1994. Export Marketing, Arihant Publishing House.

FISHERIES RESOURCE MANAGEMENT

Course No.	Course Title	Credits	Semester
Core Courses			
FRM 101	Taxonomy of Commercially Important Fish and Shellfish	3 (1+2)	I
FRM 102	Anatomy and Biology of Fish and Shellfish	3 (2+1)	II
FRM 103	Physiology of Fish and Shellfish	3 (2+1)	II
FRM 201	Inland Fisheries	2 (1+1)	III
FRM 202	Marine Fisheries	2 (1+1)	IV
FRM 301	Fish Population Dynamics and Stock Assessment	2 (1+1)	V
	Total Credits	**15 (8+7)**	
Elective Course			
FRM 401	Sustainable Fisheries Management and Conservation	3 (2+1)	VII
	Total Credits	**3 (2+1)**	
	Grand Total	**18 (10+8)**	

FRM 101	TAXONOMY OF COMMERCIALLY IMPORTANT FISH AND SHELLFISH	3 (1+2)	SEM I

Objectives

1. To identify the commercially-important fish and shell-fish species inhabited in the aquatic environment
2. To acquire knowledge on the fish and shell-fish species in the aquatic environment

Theory

Principles of taxonomy. Nomenclature, types. Classification and interrelationships. Criteria for generic and specific identification. Morphological, morphometric and meristic characteristics of taxonomic significance. Major taxa of inland and marine fishes up to family level. Commercially important freshwater and marine fishes of India and their morphological characteristics. Introduction to modern taxonomic tools: karyo-taxonomy, DNA barcoding, protein analysis and DNA polymorphism.

Study of external morphology and meristic characteristics of crustacea and mollusca. Classification of crustacea and mollusca up to the level of species with examples of commercially important species.

Practical

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.

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

Suggested Readings

1. Bal DV and Rao KV. 1990. Marine Fishes of India. 1st Revised edn. Tata McGraw Hill.
2. Day F. 1878. The Fishes of India. William Dawson and sons Ltd.
3. FAO. 2000. DNA-based molecular diagnostic techniques.
4. Fischer W and Biachi G. 1984. FAO-identification sheets for fishery purposes. Vol I-VI pages' variable
5. Hamilton F. 1822. Fishes of the River Ganges and its branches. Publ. Edinberg.
6. Jayaram KC. 2010. The freshwater fishes of the Indian Region II edition. Narendra Publishing house New Delhi
7. Kurian CV and Sebastian VO. 1986. Prawns and Prawn Fisheries of India. Hindustan Publ. Corp.
8. Jayaraman KC. 2002. Fundamentals of Fish Taxonomy. Publ.
9. Mayr E. 1977. Principles of Systematic Zoology. Tata Mc Graw Hill Publishing Co. Ltd. New Delhi, p. 428.
10. Nelson JS. 2006. Fishes of the World, 4th edn, John Wiley and Sons.
11. Ponniah AG and George John. 1998. Fish Chromosome Atlas. National Bureau of Fish Genetic Resources (NBFGR), Lucknow publication.
12. Talwar PK and Jhingran AG. 1991. Inland fishes of India and adjacent countries, Delhi Oxford and IBH Publishing Co. Pvt. Ltd. 1158 p. Vol. I and II.
13. Talwar PK and Kacker RK. 1984. Commercial Sea Fishes of India. ZSI, Kolkata. 997 p.
14. Thomas D, Kocher and Carol A Stepien (Ed.). 1997. Molecular Systematics of Fishes. Academic Press. New York. 314p.

FRM 102	ANATOMY AND BIOLOGY OF FISH AND SHELLFISH	3 (2+1)	SEM II

Objectives

1. To familiarize with the anatomy and biology of fish and shellfish
2. To understand the anatomy and developmental biology of fish and shellfish

Theory

Study of the external and internal anatomy of important groups of finfish. Study of oral region and associated structures. Digestive system and associated digestive glands. Food and feeding habits of commercially important fishes. Qualitative and quantitative methods of analysis of gut contents. Circulatory system, respiratory system, nervous system, urino-genital system, endocrine system, skeletal systems and sensory organs. Reproductive biology – maturity stages, gonado-somatic index, ponderal index, fecundity, sex ratio and spawning. Eggs and larval stages and developmental biology. Age and growth determination by direct and indirect methods. Fish migration - type and significance. Tagging and marking.

Study of external and internal organization of commercially important crustaceans and molluscs. Digestive, respiratory, circulatory, nervous and reproductive systems. Food and feeding habits, growth, moulting, length – weight relationship. Reproductive biology, larval stages. Age and growth determination by direct and indirect methods.

Practical

Study of internal organs – digestive, respiratory, circulatory, urino-genital system, nervous, skeletal systems and endocrine systems. 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.

Study of Internal Organs commercially important crustaceans and molluscs. 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

1. Barrington EJW. 1981. Invertebrate Structure and Function. 2nd edn. The English Language Book Society and Nelson.
2. Ede DA. 1978. An Introduction to Developmental Biology. Blacki
3. Jobling M. 1995. Environmental Biology of Fishes. Chapman and Hall.
4. Jobling M. 1995. Environmental Biology of Fishes. Springer.
5. Khanna, S.S. and Singh, H.R. 2014. Textbook of Fish Biology and Fisheries. 3rd edn. Narendra Publishing House.
6. Paul, J., Hart, B. and Reynolds, J. D. (Editors), 2002. Handbook of Fish Biology and Fisheries: Fisheries, Volume 2, Blackwell Science Ltd.
7. Ray, Samanta. 2015. Physiology of Finfish and Shellfish.: New Delhi New India Publishing Agency 2015: “xviii, 230p” ISBN: 978-93-83305-68-1
8. Silas EG. 1983. Development of Penaeid Prawns. CMFRI Bull. No. 28.8. Werner A. Muller, 1996. Developmental Biology, Springer. 328p
7. Tembhre, M. 1996. Anatomy and Physiology of Fishes. Vikas Publishing House.
9. Venkataramanujam, K. and Ramanathan, N. 1994. Manual of Finfish Biology. Oxford and IBH publishing Co. Pvt. Ltd 1108.
10. William O. Reece and Rowe, Eric W. 2017. Functional Anatomy and Physiology.

FRM 103	PHYSIOLOGY OF FISH AND SHELLFISH	3 (2+1)	SEM II

Objectives

1. To understand the physiological function of fish and shellfish
2. To understand concepts in physiology of fish and shellfish

Theory

Water as a biological medium. Gas exchange; Circulation; Excretion; Osmoregulation; Reproductive physiology; Muscle physiology; Sense organs; Energy and nutrient status of food; Nitrogen balance; Standard and active metabolism; Energy utilization; Effect of environmental factors on the physiology of fish and shellfish. Stress-related physiological changes. Structure and functions of important endocrine glands.

Practical

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

1. Diwan. 2007. Physiology of Marine White Shrimp: *Fenneropenaeusindicus*. Delhi Narendra Publishing House.
2. Evans DH and Claiborne JB. 2006. The Physiology of Fishes. CRC Press.
3. Evans, 2014. Physiology of Fishes. Boca Raton CRC Press 2014, 4th Edition.
4. Hoar WS and Randall DJ.1988. Fish Physiology. Academic Press.
5. Johnston, 2014. Fish Physiology (Series 1-35 volumes) New Delhi Reed Elsevier India Pvt. Ltd.
6. Ray Samanta. 2015. Physiology of Finfish and Shellfish. New Delhi, New India Pub. Agency.
7. Reinecke, 2006. Fish Endocrinology, Vol. 1. Enfield Science Publishers, Inc.
8. Reinecke, 2006. Fish Endocrinology, Vol. 2: Enfield Science Publishers, Inc.
9. Rocha 2008. Fish reproduction. Enfield Science Publishers, Inc.
10. Smith Lynwood S. 1999. Introduction to fish physiology. Narendra Publishing House.

FRM 201	INLAND FISHERIES	2 (1+1)	SEM III

Objectives

1. To understand the present exploitation and future potential of inland fisheries
2. To learn the methodologies for assessments of inland fisheries resources

Theory

Freshwater fishery regions of the world and their major fish species composition. Global inland fish production data. Capture fishery resources of India. Potential of inland water bodies with reference to the respective state. Problems in the estimation of inland fish catch data. Fishing crafts and gears. Major riverine and estuarine systems of India. Major brackish water lakes and their fisheries. Fisheries of major reservoirs / natural lakes of India. Flood-plain capture fishery- present status of their exploitation and future prospects. Cold water fisheries of India.

Practical

Analysis of species composition of commercial catches at landing and assembling centres, 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, floodplain wetlands, Coldwater bodies, net making yards.

Suggested Readings

1. Blaber JM. 1997. Fish and Fisheries in Tropical Estuaries. Chapman and Hall.
2. FAO. Technical Papers on Freshwater Fisheries.

3. Jeppe Kolding, Upali S. Amarasinghe, Jane Turpie, R., Brummett, Patrick Dugan, Pradeep Katiha 2021. Inland fisheries and Aquaculture.
4. Jhingran VG and Pathak V. 1987. Ecology and Management of Bheels in Assam: A case study of DhirBheel. In: Workshop on Development of Bheel Fisheries in Assam, held at Assam Agricultural University, Guwahati from 21st to 22nd April.
5. Jhingran VG and Sehgal KL. 1978. Cold Water Fisheries of India. J. Inland. Fish. Soc. India. Sp. Publ.
6. Jhingran VG. 1991. Fish and Fisheries of India. 3rd edn. Hindustan Publ.
7. Sugunan VV. 1997. Reservoir Fisheries of India. Daya Publ. House.
8. Ayyappan S., Moza, Usha, Gopalakrishnan, A., Meenakumari, B., Jena, J.K., Pandey, A.K. (2nd edn). 2011. Handbook of Fisheries and Aquaculture, ICAR: 1116.
9. Chandra P. 2007. Fishery Conservation, Management and Development, Fisheries and Aquatic Resources of India. Daya Publ. House.
10. FAO. Technical Papers on Freshwater Fisheries.
11. Handbook on Fisheries Statistics. 2022. Dept. of Fisheries, Ministry of Fisheries, Animal Husbandry and Dairying, Govt. of India, New Delhi.
12. Jain V., Sinha R., Singh L. P. and Tandon S. K. 2016. River Systems in India: The Anthropocene Context, Proc Indian NatnSciAcad 82 No. 3 July Spl Issue 2016 pp. 747-761
13. Jayakumar, N., Ahilan, B. and Felix, S. 2019. Inland Fisheries, Narendra Publishing House, New Delhi
14. Vishwas B. Sakhara. 2013. Inland Fisheries. Daya Publishing House.
15. Welcomme, R.L. 2001. Inland Fisheries – Ecology and Management. Wiley-Blackwell; 1st edn, UK.

FRM 202	MARINE FISHERIES	2 (1+1)	SEM IV

Objectives

1. To understand the present exploitation and future potential of marine fisheries
2. To learn the methodologies for assessments of marine fisheries resources

Theory

Classification and definition of fishery zones and fishery resources of world. Overview of marine fisheries resources of the world and India. Major exploited marine fisheries of India, their developmental history and present status. Important pelagic, demersal fish, shellfish and seaweed resources of India. Traditional, motorized and mechanized fisheries according to major gears. Potential marine fishery resources of India's EEZ. GIS and Remote sensing in marine capture fishery. Conservation and management of marine fisheries resources in India.

Practical

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

1. Blaber, J.M. 1997. Fish and Fisheries in Tropical Estuaries. Chapman and Hall.
2. Bal, D.V. and Rao, K.V. 1990. Marine Fishes of India. 1st Revised Ed. Tata McGraw Hill.
3. Chandra, P. 2007. Fishery Conservation, Management and Development, Fisheries and Aquatic Resources of India. Daya Publ. House.
4. FAO. Technical Papers on Marine Fisheries.
5. Kurian, C.V. and Sebastian, V.O. 1986. Prawns and Prawn Fisheries of India. Hindustan Publ. Corp.
6. Alok Kumar Upadhyay and Joshi, B C . 2014: Textbook of Marine Fisheries: Fisheries of World Oceans and India in Perspective. Astral International Private Limited: 232 p.
7. Mohan Joseph, M. and Pillai, N. G. K. eds 2007: Status and Perspectives in Marine Fisheries Research in India, CMFRI.
8. Pillai, V. N. and Menon, N. G. (Eds). 2000. Marine Fisheries Research and Management, CMFRI: pp 914
9. Quentin Grafton, R., Ray Hilborn, Dale Squires, Maree Tait, Meryl J. Willaims (Eds), 2010. Handbook on Marine Fisheries Conservation and Management. Oxford University Press, USA
10. Ramadoss, K. 2003. Status of Exploited Marine Fishery Resources of India. In: Joseph, M.M. and Jayaprakash, A.A., Eds., Central Marine Fisheries Research Institute, Kochi, 201-210.
11. Sinclair, M., Valdimarsson, G. 2003. Responsible fisheries in the marine ecosystem, CABI Publishing: 426 p.
12. Srivastava, C.B.L. and Sushma Srivastava, 2006. Textbook of Fishery Science and Indian Fisheries. Kitab Mahal, Classic edn. 551 p.

FRM 301	FISH POPULATION DYNAMICS AND STOCK ASSESSMENT	2 (1+1)	SEM V

Objectives

1. To understand the stock concept and principles of fisheries management
2. To understand the application of various models and their applications in fisheries management

Theory

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

Practical

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

1. Callucci VG, Saila SB, Gustafson DJ and Rothschild BJ. 1996. Stock Assessment. Quantitative methods and applications for small scale fisheries. Lewis publishers. Boca Raton, P. 527.
2. Devaraj M. 1983. Fish Population dynamics: a course manual, CIFE Bulletin 3 (10): 98p
3. Gulland JA. 1977. Fish population dynamics. John-wiley and sons. Chichester. P. 422.
4. Gulland JA. 1992. A review of length-based approaches to assessing fish stocks. FAO technical paper. 323. p.100.
5. Hilborn R and CJ Walters. 1992. Quantitative Fisheries Stock Assessment – Choice, Dynamics and Uncertainty. Pub. Chapman and Hall. 570p.
6. Pauly D. 1980. Selection of simple methods for the assessment of tropical fish stocks. FAO Fish. Circ., (729): 54p.
7. Quinn TJ and RB Deriso. 2003. Quantitative fish dynamics. Pub. Academic Press.
8. Ricker WE. 1971. Methods for the Assessment of Fish Production in Freshwaters. Blackwell, Oxford and IBH.
9. Sparre P and Venema SC. 1998. Introduction to Tropical Fish Stock Assessment. Part 1 Manual. FAO. Fisheries Tech. Paper No.301, Rome
10. Vivekanandan E. 2005. Stock assessment of tropical marine fishes. Indian Council of Agricultural Research, New Delhi.

FRM 401	SUSTAINABLE FISHERIES MANAGEMENT AND CONSERVATION	3 (2+1)	SEM VII

Objectives

1. To understand the major sustainability issues of inland and marine fisheries resources of the world and India
2. To understand the ways and means of conservation of fisheries resource

Theory

Inland fisheries: Major inland fisheries resource of the World-India-Overview. State of the fisheries- Fishing gears-and crafts- Catch composition. Marine fisheries: Major marine fisheries resources of the world and India. Overview- State of the fisheries - Fishing gears – Catch composition-pelagic, Demersal, Oceanic, Deep-sea. Sustainability issues in fisheries: Ghost fishing - Overexploitation, Overcapacity, pollution, Habitat degradation/ biodiversity loss. Damming of rivers. Interlinking of rivers, Environmental flows; Fishing Conflicts - Exotics; Trans-boundary issues, IUU fishing, inter-linking of rivers-Climate change, By-catch and discards. Sustainable fishing: Components of sustainability, Indicators and goals of sustainability, Eco-friendly fishing, Ecosystem Based Fisheries Management-resilient fishery system. Principle of fisheries Management - Management approaches-By catch reduction -

Rebuilding fishery, Rebuilding stock, Co-management - right based fishing input control (fishing efforts, mesh regulations, fishing ban, licensing, capital investments, etc.) - output control (catch quotas, minimum legal size, etc.). Fishery reserve-technical measures. Spawning aggregates; trade agreement- Market-based instruments; Access right – Catch sharing-balanced Fishing-Subsidy-certification and Traceability-Sustainable management approach in lake, Reservoir and beels. Functions and importance of Aquatic habitats: Mangrove, Corals, Seagrass beds, and dunes, Turtle nesting grounds, horseshoe crab habitat; Role and functions of aquatic habitat; Human activities and pollution sources; Effects of Conservation Practices on Aquatic Habitats and Fauna. Aquatic habitat conservation: Freshwater habitat and Marine water habitat; Erosion and sediment control-transplantation-stocking-population stabilization. Fish refugee- ex-situ conservation. Responsible fishing practices Precautionary management -Fisheries co-management: Right-based fishing - Catch sharing access right - Balanced fishing. Technical Guidelines of CCRF for responsible fishing; National and International treaties (National policy on marine fisheries - 2017; National policy on inland fisheries 2019; MFRA's; UNCLOS; UNFSA; IOTC).

Practical

Capture fisheries observation at lakes, reservoirs, river stretches, and marine landing centres. Species landings analysis. Interaction with manager's Co-operative societies and stakeholders. Fleet capacity assessment. Visit to fishery reserves to understand management. Field survey and observation of fisheries issues. Development of management plan. Suggest management plan for aquatic habitat protection- permit application form. Valuation of ecosystems – awareness on fisheries resource conservation. Visit to reservoir and assess the threats and developing plan for stock rebuilding.

Suggested Readings

1. Blaber JM. 1997. Fish and Fisheries in Tropical Estuaries Chapman and Hall.
2. Chandra P. 2007. Fishery Conservation, Management and Development. SBS Publ. Dholakia AD.
3. FAO. Technical Papers on Freshwater Fisheries.
4. Hilborn, R. C. and C. J. Walters. 1992. Quantitative Fisheries Stock Assessment. Chapman and Hall. New York, New York.
5. Jhingran VG and Pathak V. 1987. Ecology and Management of Bheels in Assam: A case study of DhirBheel. In: Workshop on Development of Bheel Fisheries in Assam, held at Assam Agricultural University, Guwahati from 21st to 22nd April.
6. Samuel CT. 1968. Marine Fisheries in India. Narendra Publ. House.
7. Sugunan VV. 1997. Reservoir Fisheries of India. Daya Publ. House
8. Mc Clanahan. 2000. Coral reefs of the Indian ocean: their ecology and conservation. Oxford University Press. 525p.
9. Nath S. (Ed.). 2008. Recent Advances in Fish Ecology Limnology and Eco Conservation. Vol. VII. Narendra Publ. House.
10. Ramachandra, 2005. Aquatic ecosystems: conservation, restoration and management. Description: New Delhi: Capital Publishing Company. 348p.
11. Young TP. 2000. Restoration Ecology and Conservation Biology. Biological Conservation.

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National Science Day-2025
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Chief Guest
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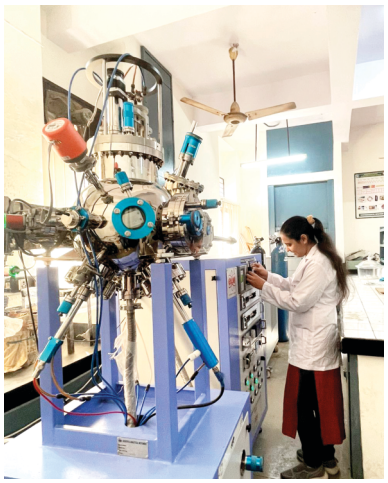
CCSHAU, Hisar

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UNIVERSITY

COLLEGE OF BASIC SCIENCES & HUMANITIES

SUPPORTING COURSES FOR B.SC. (HONS.) AGRICULTURE, B.SC. (HONS.) AGRIBUSINESS MANAGEMENT, B.SC. (HONS.) COMMUNITY SCIENCE, B.F.Sc., B.TECH (AGRICULTURAL ENGINEERING) AND B.TECH. BIOTECHNOLOGY

Course No.	Course Title	Credits	Semester
	Biochemistry		
BIOCHEM 202	Basic Biochemistry (For B.Tech. Biotechnology)	4 (3+1)	IV
BIOCHEM 302	Essentials of Plant Biochemistry (For B.Sc. (Hons.) Agriculture)	3 (2+1)	VI
	Total Credits	**7 (5+2)**	
	Botany and Plant Physiology		
BIO 101	Introductory Biology (Need based) (For B.Sc. (Hons.) Agriculture and B.Sc. (Hons.) Agribusiness Management)	1 (1+0) NG	I
BIO 103	Basic Biology (For B.Tech. Biotechnology)	2 (2+0)	I
PL PHY 201	Fundamentals of Crop Physiology (For B.Sc. (Hons.) Agriculture and B.Tech. Biotechnology)	3 (2+1)	Agri.: V Biotech: III
	Total Credits	**5 (4+1)**	
	Chemistry		
CHEM 201	Engineering Chemistry (For B. Tech. (Agricultural Engineering)	3 (2+1)	III
	Total Credits	**3 (2+1)**	
	Computer Section		
COMP 101 (SEC I)	Computer Applications in Agriculture (For B.Sc. (Hons.) Agribusiness Management)	2 (0+2)	I
COMP 202 (VAC)	Agricultural Informatics and Artificial Intelligence (For B.Sc. (Hons.) Agriculture, B.Sc. (Hons.) Agribusiness Management, B.Sc. (Hons.) Community Science, B.F.Sc. and B.Tech. Biotechnology)	3 (2+1)	Agri: III AM: III CS: IV FS: IV Biotech: IV
	Total Credits	**5 (2+3)**	
	Languages and Haryanavi Culture		
ENG 101 (AEC)	Communication Skills (For B.Sc. (Hons.) Agriculture, B.Sc. (Hons.) Agribusiness Management, B.Sc. (Hons.) Community Science, B.F.Sc., B.Tech. (Agricultural Engineering) and B.Tech. Biotechnology)	2 (1+1)	Agri: I AM: I FS: I Biotech: I CS: II AE: II

ENG 301 (AEC)	Human Values and Personality Development (For B. Tech. Agricultural Engineering)	2 (1+1)	V
	Total Credits	**4 (2+2)**	
Mathematics and Statistics			
MATH 101	Introductory Mathematics (Need based) (For B.Sc. (Hons.) Agriculture & B.Sc. (Hons.) Agribusiness Management)	1 (1+0) NG	I
MATH 103	Basic Mathematics (For B.Tech. Biotechnology)	2 (2+0)	I
MATH 201	Engineering Mathematics I (For B. Tech. Agricultural Engineering)	3 (3+0)	III
MATH 203	Biomathematics (For B.Tech. Biotechnology)	2 (2+0)	III
MATH 202	Engineering Mathematics II (For B. Tech. Agricultural Engineering)	3 (3+0)	IV
STAT 301	Biostatistics (For B.Tech. Biotechnology)	2 (1+1)	VI
STAT 302	Basic and Applied Agril Statistics (For B.Sc. (Hons.) Agriculture)	3 (2+1)	VI
STAT 401	Agricultural Statistics and Data Analysis (for B. Tech. Agricultural Engineering)	2 (1+1)	VII
STAT 402	Statistical Methods (For B.Sc. (Hons.) Community Science)	2 (1+1)	VII
	Total Credits	**19 (15+4)**	
Microbiology			
MICRO 101 (SEC II)	Production Technology for Bio-agents and Bio-fertilizers (For B.Sc. (Hons.) Agribusiness Management)	2 (0+2)	I
MICRO 102	Elementary Microbiology (For B.Tech. Biotechnology)	2 (1+1)	II
MICRO 302	Agricultural Microbiology and Phyto-remediation (For B.Sc. (Hons.) Agriculture)	2 (1+1)	VI
	Total Credits	**6 (2+4)**	
Physics			
PHY 203	Engineering Physics (For B. Tech. Agricultural Engineering)	3 (2+1)	III
	Total Credits	**3 (2+1)**	
Sociology			
SOC 101	Rural Sociology and Educational Psychology (For B.Sc. (H) Agriculture)	2 (2+0)	I
SOC 201	Rural Sociology (For B.Sc. (Hons.) Community Science)	2 (2+0)	III
SOC 202	Human Ethics (For B.Tech. Biotechnology)	1 (1+0)	IV
	Total Credits	**5 (5+0)**	

COURSE CONTENTS: DEAPRTMENT-WISE
BIOCHEMISTRY

Course No.	Course Title	Credits	Semester
BIOCHEM 202	Basic Biochemistry (For B.Tech. Biotechnology)	4 (3+1)	IV
BIOCHEM 302	Essentials of Plant Biochemistry (For B.Sc. (Hons.) Agriculture)	3 (2+1)	VI
	Total Credits	**7 (5+2)**	

BIOCHEM 202	BASIC BIOCHEMISTRY (For B.Tech. Biotechnology)	4 (3+1)	SEM IV

Objectives

1. To study the structure and functions of biomolecules of living organisms
2. To study metabolism and bioenergetics
3. To study secondary metabolites and their applications

Theory

Introduction and importance. Acids, bases and buffers of living systems. Biomolecules: carbohydrates, lipids, proteins and nucleic acids – structure, functions and properties, Vitamins and animal hormones.

Bioenergetics. Metabolism – basic concept: glycolysis, citric acid cycle, gluconeogenesis, HMP pathway, oxidative phosphorylation, fatty acid oxidation; ketone bodies.

Overview & significance of secondary metabolites: alkaloids, phenolics and their applications in food and pharmaceutical industries. Role of phytohormones: Auxin, Gibberellins, Cytokinin, Ethylene and Abscisic acid.

Practical

Qualitative tests for carbohydrates, amino acids, proteins and lipids. Extraction and characterization of lipids by TLC. Determination of acid, iodine and saponification values of oil. Extraction, quantitative estimation and separation of sugars by paper chromatography.

Suggested Readings

1. Nelson DL and Cox MM, 2017, Lehninger principles of biochemistry, 7th edn, W. H. Freeman.
2. Satyanarayana U and Chakrapani U, 2021, Essentials of Biochemistry, Elsevier.

BIOCHEM 302	ESSENTIALS OF PLANT BIOCHEMISTRY (For B.Sc. (Hons.) Agriculture)	3 (2+1)	SEM VI

Objectives

To impart the fundamental knowledge on structure and function of cellular components, biomolecules and the biological processes in plants

Theory

Biochemistry − Introduction and importance, Properties of water, pH and buffer, plant cell and its components. Bio-molecules − Structure, classification, properties and function of carbohydrates, amino acids, proteins, lipids and nucleic acids. Vitamins − physiological and metabolic role. Enzymes: General properties; Classification; Mechanism of action; Michaelis and Menten and Line Weaver Burk equation and plots; Introduction to allosteric enzymes, use of enzymes. Metabolic energy and its generation − Metabolism − Basic concepts, Glycolysis, Citric acid Cycle, Pentose phosphate pathway, oxidative phosphorylation, Fatty acid oxidation. Biosynthetic Pathways −Photosynthesis, Gluconeogenesis, nitrogen fixation, fatty acid and starch formation. Regulation of metabolic pathways. Secondary metabolites, Terpenoids, Alkaloids, Phenolic and their applications in food and pharmaceutical industries.

Practical

Preparation of standard solutions and reagents, Determination of pH, Qualitative tests of carbohydrates and amino acids, Quantitative estimation of soluble sugars and starch, Estimation of protein by Kjeldhal method and Lowry’ s method, Preparation of mineral solution from ash, Estimation of fat by Soxhlet method, Determination of acid value, saponification value and iodine number, Estimation of ascorbic acid, Qualitative/quantitative tests of secondary metabolites.

Suggested Readings

1. Nelson and Cox. 2008. Lehninger Principles of Biochemistry. Fourth/Fifth edition. Freeman (Can be downloaded)
2. Conn, Stumpf, Bruening and Doi. 2006. Outlines of Biochemistry. Fifth Edition. Wiley
3. Horton, Moran, Rawn, Scrimgeour, Perry. 2011. Principles of Biochemistry. Fifth Edition. Pearson/Prentice Hall (Can be downloaded)
4. Heldt. 2005. Plant Biochemistry. Elsevier (Can be downloaded)
5. Goodwin and Mercer. 2005. Introduction to Plant Biochemistry. 2nd edition. CBS.

BOTANY AND PLANT PHYSIOLOGY

Course No.	Course Title	Credits	Semester
BIO 101	Introductory Biology (need based) (For B.Sc. (Hons.) Agriculture and B.Sc. (Hons.) Agribusiness Management)	1 (1+0) NG	I
BIO 103	Basic Biology (For B.Tech. Biotechnology)	2 (2+0)	I
PL PHY 201	Fundamentals of Crop Physiology (For B.Sc. (Hons.) Agriculture and B.Tech. Biotechnology)	3 (2+1)	Agri.: V Biotech: III
	Total Credits	**5 (4+1)**	

BIO 101	INTRODUCTORY BIOLOGY (NEED BASED) NON-GRADIAL (For B.Sc. (Hons.) Agriculture & B.Sc. (Hons.) Agribusiness)	1 (1+0) NG	SEM I

Objectives

To impart the basics of plant cell and structure of flowers to non-biology background students.

Theory

Introduction to the living world, diversity and characteristics of life, origin of life, Evolution and Eugenics. Binomial nomenclature and classification Cell and cell division. Morphology and anatomy of flowering plants. Seed and seed germination. Plant systematics viz; Brassicaceae, Fabaceae and Poaceae. Role of animals in agriculture.

Suggested Readings

1. Biology- Text Book of class XI, NCERT, New Delhi
2. Biology- Text Book of class XII, NCERT, New Delhi

BIO 103	BASIC BIOLOGY (For B.Tech. Biotechnology)	2 (2+0)	SEM I

Objectives

1. To study the basic taxonomy and classification of plants
2. To study the features of the plant kingdom and morphology
3. To study the internal structure of plants
4. To study cells and biomolecules
5. To study the animal kingdom and nomenclature
6. To study the organisation of mammalian systems

Theory

The plant kingdom and features of each group. Morphology, modifications and functions of root, stem, leaf, flower and inflorescence. Pollination and fertilisation. Fruit types. Structure of dicot and monocot seeds, and seed germination.

Cell structure. DNA, chromosomes and genes. Cell and tissue types. Internal structure of root, stem and leaf.

Plant taxonomy, systems of classification. Characteristics and economic importance of Poaceae, Brassicaceae, Fabaceae, Malvaceae, Rutaceae, Rosaceae, Asteraceae and Solanaceae families.

Introduction to Zoology. Structure and functions of the cell and cell organelles. The difference between prokaryotic and eukaryotic cells. Structure and function of biomolecules. Types of simple and compound tissues.

Binomial nomenclature. Classification and general survey of the animal kingdom. Functional organisation of various systems of a mammal: digestive, circulatory, respiratory, excretory, nervous and reproductive. Laws of inheritance. Multiple allelism - blood groups. Genetic disorders in human and their inheritance.

Suggested Readings

1. Bendre AM and Kumar A, 1999, Textbook of Practical Botany. Vol. 2, 7th edn, Rastogi Publications.
2. Bendre AM and Pande PC, 2009, Introduction to Botany, Rastogi publications.
3. Bhatia K.N. and Tyagi M.P. 2020 Elementary Biology. A Truemen publication
4. David M Hillis; H Craig Heller; Sally D Hacker; David W Hall; David E Sadava. 2020. Life: the science of biology, 12th edn, Sunderland publication. eBook
5. Dutta AC, 1995, A Class Book of Botany, 16th edn, Oxford University Press.
6. NCERT 2021. Biology of Class XI. NCERT, India.
7. Pande PC and Jain DK, 2022, A textbook of Botany, Angiosperm. S. Chand publications.
8. Bhatia KN and Tyagi MP, 2020, Elementary Biology, A Truemen Publication.
9. Chopra G and Dhami PS, 2021, A Textbook of Biology, Pradeep Publications.
10. David MH, Craig HH, Sally DH, David WH and David ES, 2020, Life: the science of biology, 12th Ed, Sunderland Publication.
11. NCERT, 2022, Biology of Class XI, 2022-23. NCERT, India.

PL PHY 201	**FUNDAMENTALS OF CROP PHYSIOLOGY (For B.Sc. (Hons.) Agriculture and B.Tech. Biotechnology)**	**3 (2+1)**	**SEM Agri.: V Biotech: III**

Objectives

To explain about the basic physiological process of plant viz. plant cell and water relations, mineral nutrition, carbon metabolism, reproductive physiology and plant growth and development

Theory

Definitions of plant physiology and crop physiology; Importance of crop physiology; Relationship of crop physiology with other branches of crop science; Diffusion and osmosis; Physiological roles of water to crop plants; Definition of water potential and components of water potential; Water absorption by plants: Concept of active and passive absorption; Water loss by plants: Types of water loss: transpiration, stomatal physiology and guttation; Water use efficiency; Essential and beneficial elements; Passive and active transport of mineral element; Functions of essential elements; Criteria of essentiality of nutrients; Correction measures for nutrient deficiency symptoms; Foliar nutrition and root feeding − significance; Aeroponics Imbibition; Field capacity, permanent wilting point and available soil moisture; Apoplast, symplast and transmembrane, Ascent of sap − theories and mechanism; Soil-plant-atmospheric continuum. Significance of transpiration. Stomatal opening and closing mechanisms. Definition of Cavitation and embolism. Antitranspirants - types and examples. Hydroponics and sand culture. Overview of plant cell - organelle and their functions. Brief outline of: Photosynthetic apparatus, pigment system, quantum requirement and quantum yield; Structure of chloroplast, Examples of different photosynthetic pigments (chlorophyll, carotenoids, phycobilins etc.), Difference between chlorophyll a and chlorophyll b, Structure of chlorophyll a and chlorophyll b, Short discussion on quantum requirement and quantum yield, Red drop and Emerson enhancement effect, Pigment system I and II.

Introduction to light reaction of photosynthesis, Light absorption by photosynthetic pigments and transfer of energy. Source of O2 during photosynthesis: Hill reaction; Brief introduction to cyclic and non-cyclic photo-phosphorylation: production of assimilatory powers; Introduction to C3, C4 and CAM pathways: Calvin Cycle, Hatch and Slack Cycle, CAM Cycle; Significance of these pathways (concept of photorespiration, absence of photorespiration in C4 plant: Productivity of C4 plant, CAM: an adaptive mechanism); Factors affecting photosynthesis (light, temperature, CO2, O2 etc.). Outline of the process of respiration: Definition and importance, Glycolysis, Kreb Cycle and ETC, Factors affecting respiration (O2, temperature, CO2 etc.). Terminologies / Definitions: Growth, Development and Differentiation. Measurement of plant growth (fresh weight, dry weight, linear dimension, area etc.). Introduction to CGR, RGR, NAR etc. Photoperiodism: Photoperiodic Classification of plants: Short Day Plant, Long Day Plant, Day Neutral plant etc. Introduction to Photoperiodic induction site of photo-inductive perception, Role of Phytochrome Introduction to Vernalization (What is vernalization, devernalization etc.), Meaning, classification (seasonal, sequential etc), relation with abscission. Physiological and biochemical changes during senescence, Abscission and its significance, Concept of stay green, Hormonal regulation of senescence. Terminologies / Definitions: Plant hormone, Plant growth regulators (PGR), Plant growth inhibitor. Recognized classes of PGR (Auxins, Gibberellins, Cytokinins, Ethylene and Abscisic acid) and their major physiological roles, Agricultural uses of PGRs (IBA, NAA, 2, 4 −D, GAs, Kinetin etc).

Practical

Study on structure and distribution of stomata; Demonstration of imbibition, osmosis, plasmolysis, estimation of water potential, relative water content; Tissue test for mineral nutrients, identification of nutrient deficiency and toxicity symptoms in plant; Identification of nutrients by hydroponics; Estimation of photosynthetic pigments, rate of photosynthesis, respiration and transpiration; Plant growth analysis; Study on senescence and abscission, hormonal regulation of senescence; Demonstration of the effects of different PGRs on plants, Leaf anatomy of C3 and C4 plants.

Suggested Readings

1. Devlin's Exercises in Plant Physiology by Robert Devlin, Francis H. Witham and David F. Blaydes
2. Fundamentals of Plant Physiology by Lincoln Taiz, Eduardo Zeiger, Ian Max Molle and Angus Murphy
3. Plant Physiology by Robert M. Devlin and Francis H. Witham
4. Plant Physiology by Lincoln Taiz and Eduardo Zeiger
5. Plant Physiology by Frank B. Salisbury and Cleon W. Ross

CHEMISTRY

Course No.	Course Title	Credits	Semester
CHEM 201	Engineering Chemistry (For B. Tech. Agricultural Engineering)	3 (2+1)	III
	Total Credits	**3 (2+1)**	

CHEM 201	ENGINEERING CHEMISTRY (For B. Tech. Agricultural Engineering)	3 (2+1)	SEM III

Objectives

To make the students acquainted with applications of chemistry in engineering and different chemical processes in agricultural and food engineering

Theory

Phase rule**:** Phase, component, degree of freedom, application to one component system, viz. water system, sulphur system, two component system, viz. pb-Ag system, desilverisation of Pb.

Colloids**:** Classification, properties like optical activity-Tyndall effect, Brownian movement, electrical properties –electrophoresis.

Corrosion**:** causes, types and methods of prevention- proper designing. Cathodic protection using pure metal and metal alloys, use of inhibitors.

Water**:** Temporary and permanent hardness, disadvantages of hard water, scale and sludge formation of boilers, boiler corrosion.

Basic idea on thermo-gravimetric analysis, polarographic analysis, nuclear radiation, detectors and analytical applications of radio-active materials, discovery of isotopes and new elements, release of atomic energy, radio-active tracer and carbon dating.

Fuels**:** Classifications, calorific value and its determination by bomb calorimeter.

Principles of food chemistry**:** Lipids, proteins, carbohydrates and their classifications, vitamins and their importance.

Enzymes and co-enzymes important in food processing and storage, their use in manufacturing of ethanol and acetic acid by fermentation method.

Introduction to food preservatives, definition, types natural and artificial preservative and its use, colouring and flavouring reagents of foods.

Lubricants**:** Classifications, properties-viscosity, flash point and fire point mechanism, thick film, thin film and extreme pressure, neutralization point, saponification number and mechanical stability.

Polymers**:** Type of polymerization with examples (addition, free radical); Different properties of polymers chemical resistance, crystallinity. Effect of heat on polymers, general use, molecular weight determination.

Introduction to IR spectroscopy**:** Basic principles of spectroscopy, Beer-Lambarts law, types of vibration, symmetric, asymmetric vibration and it type, absorbances of different functional group in IR.

Practical

To separate colored components by using Paper Chromatography.To determine of temporary and permanent hardness of water by EDTA method; To study the different types of fuels and compare their characteristics; To study different types of foods and their ingredients; Determination of alkalinity in the given water sample; Determination of available chlorine in bleaching powder; To estimate chloride in water sample; To estimate dissolved oxygen in water sample; Determination of viscosity of lubricant by REDWOOD Viscometer; To determine flash and fire point of an oil by PENSKY MARTEN's flash point apparatus; To determine λ max and verification of Beer-Lambert law.

Suggested Readings

1. Bahl, B. S., Bahl, A. and Tuli, B. D. 2007. *Essentials of Physical Chemistry*. S. Chand and Co. Ltd, Delhi.
2. Finar, I. L. 2002. *Organic Chemistry*. Vol I and II. Pearson.
3. Glasstone, S. *Elements of Physical Chemistry*. The Macmillan Company of India Limited.
4. Jain and Jain. 2016. *Engineering Chemistry*. Dhanpat Rai Publication.
5. Jain, P. L. and Jain, M. 1994. *Engineering Chemistry*. Dhanpat Rai publishing company Pvt. Ltd, Delhi.
6. Morrison, R. T., Boyd, R. N. and Bhattacharjee, S. K. 2010. *Organic Chemistry*. Pearson.
7. Sharam, Y. R. 2013. *Elementary Organic Spectroscopy*. S Chand.

COMPUTER SECTION

Course No.	Course Title	Credits	Semester
COMP 101 (SEC I)	Computer Applications in Agriculture (For B.Sc. (Hons.) Agribusiness Management)	2 (0+2)	I
COMP 202 (VAC)	Agricultural Informatics and Artificial Intelligence (For B.Sc. (Hons.) Agriculture, B.Sc. (Hons.) Agribusiness Management, B.Sc. (Hons.) Community Science, B.F.Sc. and B.Tech. Biotechnology)	3 (2+1)	Agri: III AM: III CS: IV FS :IV Biotech: IV
	Total Credits	**5 (2+3)**	

COMP 101 (SEC I)	**COMPUTER APPLICATIONS IN AGRICULTURE (For B.Sc. (Hons.) Agribusiness Management)**	**2 (0+2)**	**SEM I**

Objectives

1. To understand the role of computer applications in modern agricultural practices.
2. To learn to use agricultural software and tools for data analysis, modeling, and decision- making.
3. To explore the application of Geographic Information Systems (GIS) and remote sensing in precision agriculture.
4. To develop skills in utilizing technology to optimize farm management, improve productivity, and reduce environmental impact.

Practical

Working with MS-DOS/Windows. Database concept and type. Database design. Data entry operation. Word processing: MS Office. Database management program. Use of electronic spreadsheet and graphics. Statistical and mathematical functions. Advanced statistical analysis Toolpak in MS Excel. Use of SPSS/SAS statistical packages. Basics of computer networking – LAN, SAN, Network topologies, Internet and Intranet – Basics of Email – Exposure to web browsing (structure of URL), Types of websites – Internet service provider – using internet news. Application of Geographic Information System (GIS) and remote sensing in agriculture

Suggested Readings

1. Computers in Agriculture: Fundamentals and Applications (Hardcover – 20 October 2016) by Sharma Manish, Anil Bhatt
2. Computer Applications in Agriculture By William Otto Rasmussen.
3. Computer Applications in Agriculture and Agribusiness (Paperback – Import, 1 June 1994) by Michael E. Newman (Author).

COMP 202 (VAC)	**AGRICULTURAL INFORMATICS AND ARTIFICIAL INTELLIGENCE (For B.Sc. (Hons.) Agriculture, B.Sc. (Hons.) Agribusiness Management, B.Sc. (Hons.) Community Science, B.F.Sc. and B.Tech. Biotechnology)**	**3 (2+1)**	**SEM Agri: III AM: III CS: IV FS: IV Biotech: IV**

Objectives

1. To acquaint student with the basics of computer applications in agriculture, multimedia, database management, application of mobile app and decision-making processes, etc.
2. To provide basic knowledge of computer with applications in Agriculture
3. To make students familiar with Agricultural-Informatics, its components and applications in agriculture

Theory

Introduction to Computers, Anatomy of Computers, Memory Concepts, Units of Memory, Operating System: Definition and types, Applications of MS-Office for creating, Editing and Formatting a document, Data presentation, Tabulation and graph creation, Statistical analysis, Mathematical expressions, Database, concepts and types, creating data base, Uses of DBMS in Agriculture. Internet and World Wide Web (WWW): Concepts and components.

Computer programming: General concepts, Introduction general programming concepts. Concepts and standard input/output operations. e-Agriculture, Concepts, design and development, Application of innovative ways to use information and communication technologies (IT) in Agriculture. Computer Models in Agriculture: Statistical, weather analysis and crop simulation models, concepts, inputs-outputs files, limitation, advantages and application of models for understanding plant processes, sensitivity, verification, calibration and validation, IT applications for computation of water and nutrient requirement of crops, Computer-controlled devices (automated systems) for Agri-input management. Smartphone mobile apps in agriculture for farm advice: Market price, post-harvest management etc. Geospatial technology: Concepts, techniques, components and uses for generating valuable agri-information. Decision support systems: Concepts, components and applications in Agriculture. Agriculture Expert System, Soil Information Systems etc., for supporting farm decisions. Preparation of contingent crop planning and crop calendars using IT tools. Digital India and schemes to promote digitalization of agriculture in India.

Introduction to artificial intelligence, background and applications, Turing test. Control strategies, Breadth-first search, Depth-first search, Heuristics search techniques: Best-first search, A* algorithm, IoT and Big Data; Use of AI in agriculture for autonomous crop management, and health, monitoring livestock health, intelligent pesticide application, yield mapping and predictive analysis, automatic weeding and harvesting, sorting of produce, and other food processing applications; Concepts of smart agriculture, use of AI in food and nutrition science etc.

Practical

Study of computer components, accessories, practice of important DoS Commands, Introduction of different operating systems such as Windows, Unix/Linux, creating files and folders, File Management .Use of MS-Word and MS Power-point for creating, editing and presenting a scientific documents, MS-EXCEL-Creating a spreadsheet, Use of statistical tools, Writing expressions, Creating graphs, Analysis of scientific data, MS-ACCESS: Creating Database, preparing queries and reports, Demonstration of Agri- information system, Introduction to World Wide Web (WWW) and its components, Introduction of programming languages such as Visual Basic, Java, Fortran, C, C++, Hands on practice on Crop Simulation Models (CSM), DSSAT/Crop-Info/Crop Syst/ Wofost, Preparation of inputs file for CSM and study of model outputs, computation of water and nutrient requirements of crop using CSM and IT tools, Use of smartphones and other devices in agro-advisory and dissemination of market information, Introduction of Geospatial technology, AR/ VR demonstration, Preparation of contingent crop planning, India Digital Ecosystem of Agriculture (IDEA).

Suggested Readings

1. Concepts and Techniques of Programming in C by Dhabal Prasad Sethi and Manoranjan, Wiley India.
2. Fundamentals of Computer by V. Rajaroman.
3. Introduction to Information Technology by Pearson.
4. Introduction to Database Management System by C. J. Date.
5. Introductory Agri-Informatics by Mahapatra, Subrat K et al, Jain Brothers Publication.

LANGUAGES AND HARYANAVI CULTURE

Course No.	Course Title	Credits	Semester
ENG 101 (AEC)	Communication Skills (For B.Sc. (Hons.) Agriculture, B.Sc. (Hons.) Agribusiness, B.Sc. (Hons.) Community Science, B.F.Sc., B.Tech. (Agricultural Engineering) and B.Tech. Biotechnology)	2 (1+1)	Agri: I AM: I FS: I Biotech: I CS: II AE: II
ENG 301	Human Values and Personality Development (for B. Tech. Agriculture Engineering)	2 (1+1)	V
	Total Credits	**4 (2+2)**	

ENG 101 (AEC)	**COMMUNICATION SKILLS (For B.Sc. (Hons.) Agriculture, B.Sc. (Hons.) Agribusiness Mangement, B.Sc. (Hons.) Community Science, B.F.Sc., B.Tech. Agricultural Engineering and B.Tech. Biotechnology)**	**2 (1+1)**	**SEM** **Agri: I** **AM: I** **FS: I** **Biotech: I** **CS: II** **AE: II**

Objectives

To acquire competence in oral, written and non-verbal communication, develop strong personal and professional communication and demonstrate positive group communication.

Theory

Communication Process**:** The magic of effective communication; Building self-esteem and overcoming fears; Concept, nature and significance of communication process; Meaning, types and models of communication; Verbal and non-verbal communication; Linguistic and non-linguistic barriers to communication and reasons behind communication gap/ miscommunication.

Basic Communication Skills: Listening, Speaking, Reading and Writing Skills; Precis writing/ Abstracting/Summarizing; Style of technical communication Curriculum vitae/resume writing; Innovative methods to enhance vocabulary, analogy questions.

Structural and Functional Grammar**:** Sentence structure, modifiers, connecting words and verbal; phrases and clauses; Case: subjective case, possessive case; objective case; Correct usage of nouns, pronouns and antecedents, adjectives, adverbs and articles; Agreement of verb with the subject: tense, mood, voice; Writing effective sentences; Basic sentence faults;

Practical

Listening and note taking; Writing skills: precis writing, summarizing and abstracting; Reading and comprehension (written and oral) of general and technical articles; Micro-presentations and Impromptu Presentations: Feedback on presentations; Stage manners: grooming, body language, voice modulation, speed;

Group discussions; Public speaking exercises; vocabulary building exercises; Interview Techniques; organization of events.

Suggested Readings

1. Allport, G. W.1937. Personality: A Psychological Interpretation. Holt, New York.
2. Brown Michele and Gyles Brandreth. 1994. How to Interview and be Interviewed. Sheldon Press, London.
3. Carnegie Dale. 1997. The Quick and Easy Way to Effective Speaking. Pocket Books, New York.
4. Francis Peter S J. 2012. Soft Skills and Professional Communication. Tata McGraw Hill, New Delhi.
5. Kumar S and Pushpa Lata. 2011. Communication Skills. Oxford University Press.
6. Neuliep James W. 2003. Intercultural Communication A Contextual Approach. Houghton Mifflin Co Boston.
7. Pease, Allan. 1998. Body Language. Sudha Publications, Delhi.
8. Raman M and Singh P. 2000. Business Communication. Oxford University Press.
9. Seely J. 2013. Oxford Guide to Effective Writing and Speaking. Oxford University Press.
10. Thomson A J and Martinet A V. 1977. A Practical English Grammar. Oxford University

ENG 301	**HUMAN VALUES AND PERSONALITY DEVELOPMENT (For B. Tech. Agricultural Engineering)**	**2 (1+1)**	**SEM V**

Objectives

1. To make students realize their potential strengths, cultivate their inter-personal skills and improve employability
2. Development of a holistic perspective based on self- exploration about themselves (human being), family, society and nature/existence.
3. Understanding (or developing clarity) of the harmony in the human being, family, society and nature/existence
4. Strengthening of self-reflection.
5. Development of commitment and courage to act.

Theory

Personality definition, Nature of personality, theories of personality and its types. The humanistic approach - Maslow's self-actualization theory, shaping of personality, determinants of personality, Type A and Type B Behaviours, personality and Organizational Behaviour. Technical Writing: Reports & its types, Letters & its types. Foundations of individual behaviour and factors influencing individual behaviour, Models of individual behaviour, Perception and attributes and factors affecting perception. Learning: Meaning and definition, theories and principles of learning,

Learning and organizational behaviour, Learning and training, learning feedback. Speaking on given topics.

Attitude and values, Intelligence- types of Intelligence, theories of intelligence, measurements of intelligence, factors influencing intelligence, intelligence and Organizational behaviour, emotional intelligence. Motivation- theories and principles, Teamwork and group dynamics. Comprehension Passages (General & Technical articles).

Practical

Learning Styles and Strategies, Motivational needs, Interpersonal Communication, Teamwork and team building, Group Dynamics, Win-win game, Conflict Management, Leadership styles, Case studies on Personality and Organizational Behaviour. Introduction to Phonetics and spoken English, Phonemic symbols, Syllable, Word Accent.

Suggested Readings

1. Andrews, Sudhir. 1988. How to Succeed at Interviews. Tata McGraw-Hill.
2. Heller, Robert. 2002. Effective Leadership. Essential Manager series. Dk Publishing.
3. Hindle, Tim. 2003. Reducing Stress. Essential Manager series. Dk Publishing.
4. Lucas, Stephen. 2001. Art of Public Speaking. New Delhi. Tata - Mc-Graw Hill.
5. Mile, D.J. 2004. Power of Positive Thinking. Delhi. Rohan Book Company.
6. Kumar, Pravesh. 2005. All about Self- Motivation. New Delhi. Goodwill Publishing House.
7. Smith, B. 2004. Body Language. Delhi: Rohan Book Company.
8. Shaffer, D. R. 2009. Social and Personality Development (6th Edition). Belmont, CA: Wadswor.
9. Human Values and Professional Ethics by R R Gaur, R Sangal, G P
10. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
11. The Story of Stuff (Book).
12. Rediscovering India - by Dharampal
13. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi
14. India Wins Freedom - Maulana Abdul Kalam Azad
15. Vivekananda - Romain Rolland (English)

MATHEMATICS AND STATISTICS

Course No.	Course Title	Credits	Semester
MATH 101	Introductory Mathematics (Need based) (For B.Sc. (Hons.) Agriculture and B.Sc. (Hons.) Agribusiness Management)	1 (1+0) NG	I
MATH 103	Basic Mathematics (For B.Tech. Biotechnology)	2 (2+0)	I
MATH 201	Engineering Mathematics I (For B. Tech. Agricultural Engineering)	3 (3+0)	III
MATH 203	Biomathematics (For B.Tech. Biotechnology)	2 (2+0)	III
MATH 202	Engineering Mathematics II (For B. Tech. Agricultural Engineering)	3 (3+0)	IV
STAT 301	Biostatistics (For B.Tech. Biotechnology)	2 (1+1)	VI
STAT 302	Basic and Applied Agril Statistics (For B.Sc. (Hons.) Agriculture)	3 (2+1)	VI
STAT 401	Agricultural Statistics and Data Analysis (For B. Tech. Agricultural Engineering)	2 (1+1)	VII
STAT 402	Statistical Methods (For B.Sc. (Hons.) Community Science)	2 (1+1)	VII
	Total Credits	**19 (15+4)**	

MATH 101	INTRODUCTORY MATHEMATICS (Need Based) (For B.Sc. (Hons.) Agriculture and B.Sc. (Hons.) Agribusiness Management)	1 (1+0) NG	SEM I

Objectives

To make the students acquainted with the basic mathematics applied in agriculture and their applications

Theory

Algebra: Progressions- Arithmetic, Geometric and Harmonic Progressions. Matrices: Definition of Matrices, Addition, Subtraction, Multiplication, Transpose and Inverse up to 3rd order by adjoint method, Properties of determinants up to 3rd order and their evaluation.

Differential Calculus: Definition - Differentiation of function using first principle, Derivatives of sum, difference, product and quotient of two functions, Methods, Increasing and Decreasing Functions. Application of Differentiation- Growth rate, Average Cost, and Marginal cost, Marginal Cost, Marginal Revenue. Partial

differentiation: Homogeneous function, Euler's theorem, Maxima and Minima of the functions of the form y = f (x) and y = f (x1, x2).

Integral Calculus: Integration -Definite and Indefinite Integrals-Methods- Integration by substitution, Integration by parts. Area under simple well-known curves.

Mathematical Models: Agricultural systems - Mathematical models - classification of mathematical models- Fitting of Linear, quadratic and exponential models to experimental data.

Suggested Readings

1. NCERT, 2012, Mathematics of Class XII, NCERT, India.
2. Sharma RD, 2014, Mathematics of Class XII, Dhanpat Rai Publisher.
3. Narayan, S. 2004. *Differential Calculus*. S. Chand and Co. Ltd. New Delhi.
4. Narayan, S. 2004. *Integral Calculus*. S. Chand and Co. Ltd. New Delhi.

MATH 103	**BASIC MATHEMATICS (For B.Tech. Biotechnology)**	**2 (2+0)**	**SEM I**

Objectives

1. To study the basic principles and functions in mathematics, like limits and continuity
2. To study differentiation and integration
3. To study matrices and determinants

Theory

Functions: Defination, types of functions. Limit: Introduction, left-handed and right-handed limits, general rules for calculating limits, Standard limits. Continuity: Definition of continuity, continuity of algebraic functions, continuity of trigonometric and exponential functions. Types of discontinuity

Differentiation: Differentiation by the first principle, sum, difference, product and quotient formulae, differentiation using the chain rule, differentiation of functions in parametric and implicit form, logarithmic differentiation, geometrical interpretation of derivative. Successive differentiation, geometrical interpretation of derivative, maxima and minima, tangent and normal.

Integration: Integration of simple functions, Integration by substitution, integration by partial fractions, integration by parts, integration by trigonometric substitution.

Matrices and Determinants: Definition of matrix, addition, subtraction and multiplication, inverse of matrix. Properties of determinants Solution of linear equations by Cramer's rule and the inverse of a matrix.

Suggested Readings

1. NCERT, 2012, Mathematics of Class XII, NCERT, India.
2. Sharma RD, 2014, Mathematics of Class XII, Dhanpat Rai Publisher.

MATH 201	ENGINEERING MATHEMATICS I (For B. Tech. Agricultural Engineering)	3 (3+0)	SEM III

Objectives

To make the students acquainted with the basic mathematics, including calculus, Matrices and complex analysis applied in engineering and their applications in solving engineering problems

Theory

Differential calculus: Functions of two or more variables, Taylor's and Maclaurin's expansions, Maxima and minima.

Integral calculus: Double integrals, change of order of integration, triple integrals, application of double and triple integrals to find area and volume.

Vector calculus: Scalar and vector point functions, vector differential operator Del, gradient of scalar point function, divergent and curl of vector point function and their physical interpretations, line, surface and volume integrals, Green's, Stock's and Divergence theorem (without proofs).

Fourier series: Periodic functions, Euler's formulae, functions having arbitrary period, even and odd functions, half-range series expansion, series expansion of functions with finite discontinuity.

Complex Analysis: Functions of a complex variable, limit, continuity and analytic function, Cauchy-Reimann equations, harmonic functions.

Matrices: Elementary transformations, Gauss elimination, Gauss-Jordan method to find the inverse of a matrix. rank of a matrix, solution of linear equations, Eigen values and Eigen vectors, Cayley-Hamilton Theorem-its use to find the inverse of a matrix, linear transformation, diagonalization of matrices.

Suggested Readings

1. Grewal, B. S. 2004. Higher Engineering Mathematics. Khanna Publishers Delhi.
2. Narayan, S. 2004. A Text Book of Vector. S. Chand and Co. Ltd. New Delhi.
3. Narayan, S. 2004. Differential Calculus. S. Chand and Co. Ltd. New Delhi.
4. Narayan, S. 2004. Integral Calculus. S. Chand and Co. Ltd. New Delhi.

MATH 203	BIOMATHEMATICS (For B.Tech. Biotechnology)	2 (2+0)	SEM III

Objectives

1. To study the basic theories of mathematics
2. To study factor reduction and eigenvalues
3. To study the applications of biomathematics

Theory

Rolle's theorem, Lagrange's theorem, Taylor's and Maclaurin's series. Partial differentiation, Euler's theorem on homogeneous functions, and change of variable. Jacobian, maxima and minima of two or more than two variables, Elementary transformations, Rank of matrix, Echelon form, Solution of system of linear

equations, eigenvalues and eigenvectors of a matrix. Reduction formulae, definite integrals and their properties, Area under simple, well known curves.

Solution of ordinary differential equation of first degree and first order and their application for the determination of the volume of blood and drug distribution. Epidemic models, simultaneous differential equation of first order and their applications to predator models. Linear differential equations of higher order and their applications to the simple biological problem. Numerical methods for solving algebraic and transcendental equations.

Suggested Readings

1. Grewal BS, 2013, Higher Engineering Mathematics, Khanna Publishers.
2. Rastogi SK, 2008, Biomathematics, Krishna Prakashan Media Pvt. Ltd.
3. Srivastava AC and Srivastava PK, 2011, Engineering Mathematics, Vol. I, PHI Learning Pvt. Ltd.
4. Srivastava AC and Srivastava PK, 2011, Engineering Mathematics, Vol.III, PHI Learning Pvt. Ltd.

MATH 202	ENGINEERING MATHEMATICS II (For B. Tech. Agricultural Engineering)	3 (3+0)	SEM IV

Objectives

To make the students acquainted with the application of various advanced mathematics such as differential equations, Laplace transform and applications of numerical methods in engineering.

Theory

Ordinary Differential Equations: First order differential equations, exact and reducible to exact form by integrating factors, linear differential equation and Bernoulli's equation, equations of first order and higher degree, Clairaut's equation. Higher order differential equations: Methods of finding complementary functions and particular integrals, methods of variation of parameters, Cauchy's and Legendre's linear equations, simultaneous linear differential equations with constant coefficients.

Partial Differential Equations: Partial derivative and total derivative, homogeneous functions and Euler's theorem. Formation of PDE, higher order linear PDE with constant coefficients, solution of non-linear PDE, Charpit's method.

Laplace Transform: rules for Laplace transform and inverse Laplace transform, applications to find solutions of ordinary and simultaneous differential equations.

Numerical Methods: Finite difference operators and their relationship, factorial notation. Newton's forward and backward interpolation formula, Newton's divide difference interpolation and Lagrange's interpolation formula, numerical differentiation and integration rule, numerical solutions of ODE by Taylor's series, Euler's and modified Euler's method, Runge-Kutta method of order four.

Suggested Readings

1. Grewal, B S. 2004. Higher Engineering Mathematics. Khanna Publishers Delhi.
2. Narayan, S. 2004. A Text Book of Vector. S. Chand and Co. Ltd., New Delhi.
3. Narayan, S. 2004. Differential Calculus. S. Chand and Co. Ltd., New Delhi.
4. Narayan, S. 2004. Integral Calculus. S. Chand and Co. Ltd. New Delhi.
5. Ramana, B. V. 2008. Engineering Mathematics. Tata McGraw-Hill, New Delhi.

STAT 301	BIOSTATISTICS (For B.Tech. Biotechnology)	2 (1+1)	SEM VI

Objectives

1. To study the variables and descriptive statistics
2. To study various distributions
3. To study experimental data analysis and interpretation

Theory

Random variables: expected value and its variance; probability distribution of random variables; conditional probability; Bayes' theorem and its applications; introduction to uniform, binomial, Poisson, normal, exponential, and gamma probability distributions.

Random mating populations, Hardy-Weinberg Law. Introduction to Poisson process and Markov chains. Transition probability matrix, n-step transition probabilities, steady state. Random walk models. Sensitivity and specificity. Positive and negative predictive values.

Chi-square test: testing heterogeneity, use in the genetic experiment, detection of linkage, linkage ratios and their estimation. Analysis of variance. One-way and two-way classification with interaction. Analysis of covariance. Incomplete block designs. Estimation and significance of genotypic and phenotypic variation.

Practical

Expected value and variance of discrete and continuous distributions. Uniform, binomial, Poisson, normal, exponential and gamma probability distributions. Hardy-Weinberg Law. Construction of the transition probability matrix in Markov Chains. Calculation of sensitivity and specificity. Positive and negative predictive values. Detection and linkage using chi-square test; one-way and two-way analysis of variance. Analysis of covariance. Incomplete block designs. Estimation of heritability.

Suggested Readings

1. Gupta SC, Kapoor VK, 2007, Fundamentals of applied statistics, 4th edn, S Chand and Sons.
2. Kaps M and Lamberson WR, 2017, Biostatistics for Animal Science, 3rd edn, CABI.
3. Triola MM, Triola MF and Roy J, 2017, Biostatistics for the Biological and Health Sciences, 2nd edn, Pearson.

STAT 302	BASIC AND APPLIED AGRIL STATISTICS (For B.Sc. (Hons.) Agriculture)	3 (2+1)	SEM VI

Objectives

To provide an idea on statistical concepts of both descriptive and inference Statistics which will be useful to do statistical analysis

Theory

Introduction to Statistics and its Applications in Agriculture: Types of Data. Scales of measurements of Data. Summarization of Data. Classification of Data. Frequency Distribution. Methods of Classification. Definition of Grouped and Ungrouped Data. Definition of Class Interval (formula for determining the no. of class interval), Width of CI, Class Limits (Boundaries), Mid Points. Types of Frequency Distribution. Diagrammatic Presentation of Data. Bar Diagrams −Simple, Multiple, Sub-divided and Percentage Bar Diagrams. Pie-diagram. Graphical Presentation of Data − Histogram, Frequency Polygon and Ogives.

Measures of Central Tendency: Requisites for an Ideal Measure of Central Tendency. Different Types of Measure. Arithmetic Mean− Definition, Properties, Merits, Demerits and Uses. A.M. (examples) for Grouped and Ungrouped Data. Step-deviation Method. Weighted Mean. Definition of Geometric Mean and Harmonic Mean. Relationship between A.M., G.M. and H.M. Median-Definition, Merits, Demerits and Uses. Graphical Location of Median. Mode- Definition, Merits, Demerits and Uses. Graphical Location of Mode. Relationship between Mean, Median and Mode.

Measures of Dispersion: Characteristics for an Ideal Measure of Dispersion. Different Types of Measures of Dispersions. Definition of Range, Interquartile Range, Quartile Deviation and Mean Deviation. Standard Deviation- Definition, Properties. S.D. and Variance for Grouped and Ungrouped Data. Variance of Combined Series. Co-efficient of Dispersions. Co-efficient of Variation.

Measures of Skewness and Kurtosis: Definition of Symmetrical Distribution. Definition of Skewness, Measures of Skewness. Definition of Kurtosis. Measure of Kurtosis. Relationship between Mean, Median and Mode for Symmetrical and Skewed Distribution.

Probability Theory and Normal Distribution: Introduction to Probability. Basic Terminologies. Classical Probability-Definition and Limitations. Empirical Probability- Definition and Limitations. Axiomatic Probability.

Addition and Multiplication Theorem (without proof): Conditional Probability. Independent Events. Simple Problems based on Probability. Definition of Random Variable. Discrete and Continuous Random Variable. Normal Distribution-Definition, Prob. Distribution, Mean and Variance. Assumptions of Normal Distribution. Normal Probability Curve. Correlation and Regression. Definition of Correlation. Scatter Diagram. Karl Pearson's Coefficient of Correlation. Types of Correlation Coefficient. Properties of Correlation Coefficient. Definition of Linear Regression. Regression Equations. Regression Coefficients. Properties of Regression Coefficients. Tests of Significance. Definition. Null and Alternative Hypothesis. Type

I and Type II Error. Critical Region and Level of Significance. One Tailed and Two Tailed Tests. Test Statistic. One Sample, Two Sample and Paired t-test with Examples: F-test for Variance. ANOVA and Experimental Designs. Definition of ANOVA. Assignable and Non assignable Factors. Analysis of One-way Classified Data. Basic Examples of Experimental Designs. Terminologies. Completely Randomized Design (CRD). Sampling Theory. Introduction. Definition of Population, Sample, Parameter and Statistic. Sampling Vs Complete Enumeration. Sampling Methods. Simple Random Sampling with Replacement and without Replacement. Use of Random Number Table.

Practical

Diagrammatic and Graphical representation of data. Calculation of A.M., Median and Mode (Ungrouped and Grouped data). Calculation of S.D. and C.V. (Ungrouped and Grouped data). Correlation and Regression analysis. Application of t-test (one sample, two sample independent and dependent). Analysis of variance one-way classification. CRD. Selection of random sample using simple random sampling.

Suggested Readings

1. Fundamentals of Statistics by D. N. Elhance, Kitab Mahal Publishers.
2. Fundamentals of Applied Statistics by S.C. Gupta and V. K. Kapoor, Sultan Chand and Sons.
3. Basic Statistics by B. L. Agarwal, New Age International Publishers.
4. Agricultural Statistics by S.P. Singh and R.P.S. Verma, Rama Publishing House.
5. Agriculture and Applied Statistics-I by P.K. Sahu, Kalyani Publishers.
6. Agriculture and Applied Statistics-II by P. K. Sahu and A. K. Das, Kalyani Publishers.

STAT 401	**AGRICULTURAL STATISTICS AND DATA ANALYSIS (For B. Tech. Agricultural Engineering)**	**2 (1+1)**	**SEM VII**

Objectives

To make the students acquainted with important statistical data analysis tools and application of these for research in agricultural engineering

Theory

Introduction to statistics: Definition, advantages and limitations; Data- types of data, quantitative and qualitative; variable - discrete and continuous; Frequency distribution table: construction of frequency distribution table (inclusive and exclusive)- number of classes, length of class, tally marks, frequency, class midpoint, cumulative frequencies, frequency curves, graphs and charts. Measures of central tendency: Definition, characteristics of ideal average, different measures; arithmetic mean, median, mode, geometric mean and harmonic mean for grouped and ungrouped data, merits and demerits; Measures of dispersion: definition, different measures (absolute and relative); range, quartile deviation, mean deviation, standard deviation (SD), variance and coefficient of variation. Probability: Definition and

concept of probability; Random variable: concept of random variable and expectation; Simple linear correlation: concept, definition, types and its properties; Simple linear regression: concept, definition and its properties; Normal distribution: definition, density function, curve, properties, standard normal distribution (SND), properties including area under the curve (without proof); Binomial distribution: definition, density function and properties; Poisson distribution: definition, density function and properties; Introduction to sampling: definition of statistical population, sample, random sampling, parameter, statistic, sampling distribution, concept of standard error of mean. Testing of hypothesis – hypothesis, null hypothesis, types of hypotheses, level of significance, degrees of freedom – statistical errors; Large Sample test (Z-test), small sample t-test (one tailed, two tailed and paired tests); Testing of significance through variance (F-test), Chi-square test: goodness of fit and testing of independence of attributes (2 × 2 contingency table)

Practical

Construction of frequency distribution tables and frequency curves; Computation of arithmetic mean, median and mode for un-grouped and grouped data; Computation of harmonic and geometric mean; Computation of standard deviation (SD); Variance and coefficient of variation for un-grouped and grouped data; Computation of skewness, kurtosis; Standard normal distribution test for single sample mean (population SD known and unknown); SND test for two samples means (population SD known and unknown); Computation of binomial distribution; Computation of Poisson distribution; Calculation of correlation coefficient and its testing; Calculation of regression coefficient, regression line; Student's t-test for single sample mean; t-test for two samples means; Paired t test; F– test for equality for two sample variance test; Computation of Chi-square test: goodness of fit and testing of independence of attributes (2 × 2 contingency table) and m × n.

Suggested Readings

1. Agrawal, B. L. 1991. Basic Statistics. Wiley Eastern Ltd. New Age International Ltd.
2. Chandel, S. R. S. 1999. A Handbook of Agricultural Statistics. Achal Prakasan Mandir, Kanpur
3. Gupta, S. C. and Kapoor, V. K. 1970. Fundamentals of Mathematical Statistics. Sultan Chand & Sons. Gupta, S. C. and Kapoor, V. K. 2019. Fundamental Applied Statistics. Sultan Chand & Sons.
4. Nageswara Rao, G. 2007. Statistics for Agricultural Sciences. BS Publications.
5. Rangaswamy, R. 2018. A Text Book of Agricultural Statistics. New Age Int. Publications Ltd.

STAT 402	**STATISTICAL METHODS (For B.Sc. (Hons.) Community Science)**	**2 (1+1)**	**SEM VII**

Objectives

To develop understanding among students about sampling and data analysis techniques, methods of data analysis using various statistics.

Theory

Introduction to statistics and its applications in agriculture, graphical representation of data, measures of central tendency. Dispersion and their merits and demerits. Probability and distribution: definition of probability, addition and multiplication theorem (without proof). Simple problems based on probability. Binomial and Poisson Distributions. Correlation and regression: definition of correlation, Scatter Diagram. Karl Pearson's Coefficient of Correlation, Spearman correlation coefficient and their properties. Linear Regression Equations. Introduction to Test of Significance, One sample; two sample test t for Means, Chi-Square Test of Independence of Attributes in 2 ×2 Contingency Table. Introduction to Sampling Methods, Sampling versus Complete Enumeration, Simple Random Sampling with and without replacement, Use of Random Number Tables for selection of Simple Random Sample. Introduction to various statistical packages.

Practical

Graphical Representation of Data. Measures of Central Tendency (Ungrouped data) with Calculation of Quartiles, Deciles & Percentiles. Measures of Central Tendency (Grouped data) with Calculation of Quartiles, Deciles & Percentiles. Measures of Dispersion (Ungrouped Data). Measures of Dispersion (Grouped Data). Moments, Measures of Skewness & Kurtosis (Ungrouped Data). Moments, Measures of Skewness & Kurtosis (Grouped Data). Correlation & Regression Analysis. Application of One Sample t-test. Application of Two Sample Fisher's test. Chi-Square test of Goodness of Fit. Chi-Square test of Independence of Attributes for 2 ×2 contingency table. Selection of random sample using Simple Random Sampling. Use of software packages.

Suggested Readings

1. Agarwal, B. L. 2006. Basic Statistics. New Age International Publisher.
2. Gupta SC. 2006. *Fundamentals of Statistics.* Himalaya Publ. House.
3. Panse VG & Sukhatme PV. 1985. *Statistical Methods for Agricultural Workers.* ICAR. Rao GN. 2007. *Statistics for Agricultural Science.* Oxford & IBH.
4. Snedecor GW & Cochran WG. 1968. *Statistical Methods.* Oxford & IBH.
5. Sprent P. 1993. Applied Non-parametric Statistical Methods. 2nd Ed. Chapman & Hall.
6. Sukthame & Ashok C. 1984. *Sampling Theories and Surveys with Application.* 3rd Ed. ICAR.
7. Wetherill GB. 1982. Elementary Statistical Methods. Chapman & Hall.
8. William S. Cleveland (1994) The Elements of Graphing Data, 2ndEd., Chapman & Hall

MICROBIOLOGY

Course No.	Course Title	Credits	Semester
MICRO 101 (SEC II)	Production Technology for Bio-agents and Bio-fertilizers (For B.Sc. (Hons.) Agribusiness Management)	2 (0+2)	I
MICRO 102	Elementary Microbiology (For B.Tech. Biotechnology)	2 (1+1)	II
MICRO 302	Agricultural Microbiology and Phyto-remediation (For B.Sc. (Hons.) Agriculture)	2 (1+1)	VI
	Total Credits	**6 (2+4)**	

MICRO 101 (SEC II)	**PRODUCTION TECHNOLOGY FOR BIO-AGENTS & BIO-FERTILIZERS (For B.Sc. (Hons.) Agribusiness Management)**	**2 (0+2)**	**SEM I**

Objectives

1. To understand the principles and methods of producing bio-agents and bio-fertilizers.
2. To learn techniques for mass production and formulation of beneficial microorganisms.
3. To explore the role of bio-agents and bio-fertilizers in sustainable agriculture and soil health management.
4. To develop skills to integrate bio-agents and bio-fertilizers into crop production systems for enhanced yield and reduced environmental impact.

Practical

Agricultural Microbiology: Relevance of Biofertilizer in Agriculture. Types of Biofertilizers [(a) Nitrogen fixers: Rhizobium, Azotobacter, Azospirillum, Glucano acetobacter, Cyanobacteria and Azolla; (b) P-solubilizers: PSB, PSF; (c) K-solubilizers; (d) Zn-solubilizers; (e) P-mobilizers: AM fungi; (f) Development of consortia]. Mass Production Techniques [(a) Carrier based; (b) Liquid Biofertilizers]. Methods of application. Quality Control (Standards as per FCO (1985) amended in 2009).

Suggested Readings

1. Atlas Bartha. Microbial Ecology - Fundamentals and Application. Pearson (Fourth edn).
2. Bhoopander Giri, Ram Prasad et al. Biofertilizers for Sustainable Agriculture and Environment (Soil Biology Book 55).
3. Bikas R. Pati and Santi M. Mandal. Recent Trends in Biofertilizers.
4. Eiri Board. Handbook of Biofertilizers and Vermiculture. 1 January 2009.

5. Himadri Panda. Complete Technology Book on Biofertilizer and Organic Farming.
6. J. Nicklin, K. Graeme-Cook, T. Paget and R. Killington. Instant Notes in Microbiology. Viva.
7. M K Rai. Handbook of Microbial Biofertilizers.
8. Mark S. Coyne. Soil Microbiology - An Exploratory Approach. Delmar Publishers-2004
9. Michael Madigan, John Martinko, David Stahl and David Clark. Brock-Biology of Microorganisms. Pearson (Thirteen Edition).

MICRO 102	ELEMENTARY MICROBIOLOGY (For B.Tech. Biotechnology)	2 (1+1)	SEM II

Objectives

To study the-

1. History of microbiology and major groups of eukaryotes and prokaryotes
2. Preservation methods and repositories
3. Bacterial growth and metabolism
4. Applications of microbes

Theory

History of microbiology and its applied areas. Microorganisms and their role in health and the environment. Control and prevention measures against microorganisms/ diseases. Introduction to eukaryotic and prokaryotic cells. Major groups of eukaryotes: fungi, algae and protozoa. Major groups of prokaryotes: bacteria, archaea, rickettsia and chlamydia. Preservation of microorganisms and microbial repositories at the national and international levels.

Bacterial growth. Metabolism in bacteria, ATP generation, chemoautotrophy, photoautotrophy, respiration, and fermentation. Viruses, Bacteriophages, structure and properties, lytic and lysogenic cycles, viroids, and prions. Role of microorganisms in nutrient recycling (Biogeochemical cycles)

Beneficial microorganisms in agriculture, biofertilisers, and microbial pesticides. Microbes in composting and biodegradation. Microbiology of water and food.

Practical

Microscope and other instruments in a microbiological laboratory. Media preparation, sterilisation and aseptic methods for isolation, identification, preservation and storage. Identification of bacteria by staining methods. Purification of microorganisms by streak plate method. Enumeration of bacteria by pour plate and spread plate methods. Micrometry.

Suggested Readings

1. Woolverton CJ, Sherwood LM, and Willey JM, 2016, Prescott's Microbiology, McGraw-Hill Education.

MICRO 302	AGRICULTURAL MICROBIOLOGY AND PHYTO-REMEDIATION (For B.Sc. (Hons.) Agriculture)	2 (1+1)	SEM VI

Objectives

1. To get an introduction to microbiology with specific focus on its significance in agriculture science
2. To get acquainted with the bacterial structure and the function of the different bacterial components
3. To get highlights on different fields of microbiology
4. To get highlights on the bioremediation of polluted soils using microbial mediators and phytoremediation
5. To get a concept of biological control and the role of biopesticides in plant disease management.

Theory

Introduction to Microbiology: Definition, applied areas of Microbiology and Importance of Microbiology. History of Microbiology: Discovery of microscope, spontaneous generation theory, Germ theory of diseases, Immunization, fermentation, and origin of life**.** Bacteria: cell structure, nutritional classification of bacteria, growth. Bacterial genetics: Genetic recombination- transformation, conjugation and transduction, genetic engineering. Soil Microbiology: Nutrient mineralization and transformation**,** Air Microbiology: Phyllosphere microflora, Phylloplane microflora, microflora of floral parts etc. Food Microbiology: Microbial spoilage and principles of food preservations, Food poisoning**.** Water Microbiology: Types of water, water microorganisms, and microbial analysis of water e.g. coliform test, Purification of water. Industrial Microbiology: Microbial products, Biodegradation, Biogas production, Biodegradable plastics etc. Biological control: Microbial biopesticides for plant disease management Concepts of rhizosphere microbiology- Rhizodeposits - biochemical nature, release mechanism in rhizosphere, function, Carbon flow in rhizosphere, Rhizosphere microbiomeresidents and their roles. Potential of plant growth promoting rhizobacteria (PGPR) and endophytes on soil health and sustainability**.** Bioremediation of polluted soils using microbial mediators**.** Phytoremediation of polluted soils**.**

Practical

Study of the microscope; Acquaintance with laboratory material and equipment; Microscopic observation of different groups of microorganisms: moulds & yeasts; Direct staining of bacteria by crystal violet; Negative or indirect staining of bacteria by nigrosin; Gram staining of bacteria; Study of phyllosphere and rhizosphere microflora; Measurement of microbial growth; Preparation of culture media; Isolation and purification of rhizospheric microbes; Isolation and purification of N-fixers; Isolation and purification of Nutrient solubilizers; Isolation and purification of Endophytes.

Suggested Readings

1. Pelczar, M.J., Chan, E.C.S. and Kreig, N.R. 2002. Microbiology. 5th Edition, Tata McGraw-Hill, New Delhi.
2. Rangaswami, G. and Bagyaraj, D. J. 2005. Agricultural Microbiology. Prentice-Hall of India Pvt. Ltd., New Delhi.
3. Mukherjee, N. and Ghosh, T. 2004. Agricultural Microbiology. Kalyani Publishers, Calcutta
4. Dubey, H.C. 2007. A Textbook of Fungi, Bacteria and Viruses. Vikas Publishing House Ltd., New Delhi − 10014
5. Salyers, A. A. and Whitt, D. D. 2001. Microbiology: diversity, disease, and the environment. Fitzgerald Science Press, Inc.
6. Prescott, L. M. 2002. Microbiology 5th Edition. McGraw-Hill Inc, US

PHYSICS

Course No.	Course Title	Credits	Semester
PHY 203	Engineering Physics (For B. Tech. Agricultural Engineering)	3 (2+1)	III
	Total Credits	**3 (2+1)**	

PHY 203	ENGINEERING PHYSICS (For B. Tech. Agricultural Engineering)	3 (2+1)	SEM III

Objectives

To make the students acquainted with applications of physics in engineering and different physical processes in agricultural engineering

Theory

Unit-I: Magnetism : Dia, para and ferro-magnetism- classification; Langevin theory of dia, and para magnetism, adiabatic demagnetization, Weiss molecular field theory and ferromagnetism, Curie-Weiss law.

Unit-II: Introduction to quantum mechanics : Wave particles duality, photoelectric effect, de-Broglie concept, uncertainty principle, wave function, time dependent and time independent Schrodinger equation.

Unit-III: Spectroscopy : Qualitative explanation of Zeeman effect, Stark effect and Paschen back effect, Raman spectroscopy.

Unit-IV: Solid state physics : Statement of Bloch function, bands in solids, distinction between metals, insulators and semi-conductors; Semiconductors: intrinsic and extrinsic semi-conductors, donors and acceptor levels, law of mass action, determination of energy gap in semi-conductors, Hall effect; Superconductivity: super conductivity, critical magnetic field, Meissner effect, Type I and II superconductors, isotope effect, London equations, BCS Theory, Josephsons effect, DC and AC squids, introduction to high Tc superconductors.

Unit-V: LASERS and MASERS : Spontaneous and stimulated emission, Einstein A & B coefficients, population inversion, Ruby lasers, He-Ne laser and semiconductor laser; Masers.

Unit-VI: Optical fibre and Illumination : Optical fibre**:** Physical structure, basic theory, type of modes, characteristics of optical fibre and applications.

Illumination**:** Laws of illumination, luminous flux, luminous intensity, candle power and brightness.

Practical

To verify law of transverse vibrations along a string using electrical tuning fork; To study hysteresis loss of magnetic materials; To demonstrate the Meissner effect; To measure the transition temperature of a high; temperature superconductor; Determine dielectric constant of material using De Sautys bridge; Study the variation of magnetic field with distance along the axis of a current carrying circular coil and to determine the radius of the coil; Determine the energy band gap in a semi-conductor

using a p-n junction diode; Determine the low resistance using Carey Foster bridge without calibrating the bridge wire.

Suggested Readings

1. Avadhanulu M N. 2013. An Introduction to Lasers theory and applications. S. Chand Publication
2. Chattopadhyay D and Rakshit P C. 2011. Electricity and Magnetism. S. Chand
3. Ghatak A K and Lokanathan S. 2022. Quantum Mechanics, Theory and Application. Trinity Press.
4. Griffiths D J and Schroeter 2018. Introduction to Quantum Mechanics. Cambridge University Press.
5. Khandelwal D P. 1985. A laboratory Manual of Physics. Vani Publications.
6. Kittel C. 2005. Introduction to Solid State Physics. Wiley Eastern Pvt. Ltd.
7. Mani H S and Mehta G K. 2022. Modern Physics. Affiliated East-West Press.
8. Omar M A. 2002. Elementary Solid State Physics. Pearson.
9. Prakash S. 2011. Optics. Pragati Prakashan, Meerut.
10. Saraf B and Khandelwal D P. 1982. Physics through Experiments, Vol. I & II. Vikas Publication, New Delhi.
11. Subramanyam N, Lal B and Avadhanulu M N. 2012. A Text book of Optics. S. Chand.
12. Taneja, S.P. 2004. Modern Physics for Engineers, R. Chand & CO, New Delhi.

SOCIOLOGY

Course No.	Course Title	Credits	Semester
SOC 101	Rural Sociology and Educational Psychology (For B.Sc. (Hons.) Agriculture)	2(2+0)	I
SOC 201	Rural Sociology (For B.Sc. (Hons.) Community Science)	2 (2+0)	III
SOC 202	Human Ethics (For B.Tech. Biotechnology)	1 (1+0)	IV
	Total Credits	**5 (5+0)**	

SOC 101	RURAL SOCIOLOGY AND EDUCATIONAL PSYCHOLOGY (For B.Sc. (Hons.) Agriculture)	2 (2+0)	SEM I

Objectives

Provide knowledge on concept and importance of sociology and rural sociology as well as the relationship with Extension Education

Theory

Sociology and rural sociology: Meaning, definition, scope, importance of rural sociology in Agricultural Extension, and interrelationship between rural sociology and Agricultural Extension. Extension Education and Agricultural Extension: Meaning, definition, scope, and importance. Indian Rural Society: important characteristics, differences and relationship between rural and urban societies. Social Groups: Meaning, definition, classification, factors considered information and organization of groups, motivation in group formation and role of social groups in Agricultural Extension.

Social Stratification: Meaning, definition, functions, basis for stratification, forms of social stratification- characteristics and- differences between class and caste system. Cultural concepts: culture, customs, folkways, mores, taboos, rituals. Traditions: Meaning, definition and their role in Agricultural Extension. Social Values and Attitudes: Meaning, definition, types and role of social values and attitudes in agricultural Extension. Social Institutions: Meaning, definition, major institutions in rural society, functions, and their role in agricultural Extension. Social Organizations: Meaning, definition, types of organizations and role of social organizations in agricultural Extension. Social Control: Meaning, definition, need of social control and means of social control. Social change: Meaning, definition, nature of social change, dimensions of social change and factors of social change. Leadership: Meaning, definition, classification, roles of leader, different methods of selection of professional and lay leaders. Training of Leaders: Meaning, definition, methods of training, Advantages and limitations in use of local leaders in Agricultural Extension, Psychology and educational psychology: Meaning, definition, scope, and importance of educational psychology in Agricultural Extension. Intelligence: Meaning, definition, types, factors affecting intelligence and importance of intelligence in Agricultural Extension. Personality: Meaning, definition, types, factors influencing

the personality and role of personality in agricultural Extension. Teaching: Learning process: Meaning and definition of teaching, learning, learning experience and learning situation, elements of learning situation and its characteristics. Principles of learning and their implication of teaching.

Suggested Readings

1. A. R. Desai -Rural Sociology in India
2. Dahama O. P. and Bhatnagar, O. P. - Education and Communication for Development
3. J.B. Chitambar -Introductory Rural Sociology
4. M.B. Ghorpade- Essential of psychology
5. C.N. Shankar Rao – Sociology: Principles of Sociology with an Introduction to Sociological Thought. S Chand and Company Ltd. New Delhi.
6. Prepared You Tube videos
7. R Velusamy Textbook on Rural Sociology and Educational Psychology
8. Ray, G. L. -Extension Communication and Management
9. Sandhu A. S. -Textbook on Agricultural Communication
10. Web Materials

SOC 201	RURAL SOCIOLOGY (For B.Sc. (Hons.) Community Science)	2 (2+0)	SEM III

Objectives

1. To develop understanding about sociological concepts with special reference to rural community.
2. To understand approaches to rural planning and status of rural women

Theory

Sociology and Rural sociology – Meaning and significance; Difference between rural and urban community; Indian rural social stratification: Caste & Class- Concept, characteristics and difference, Change in social stratification and implementation of constitutional provisions; Indian rural institutions: Social- Family and marriage (Nature, forms and changes), Economic- Jajmani system and division of labour, Political- Panchayati Raj; Religion: Functional significance of beliefs, traditions and customs; Rural poverty: Meaning, types and causes; Rural social change: Concept, process and factors of transformation; Planned social change- Approaches to rural planning, improvement and transformation; Status of women in rural India and their role in rural and agricultural development.

Suggested Readings

1. Chitambar, J.B. (1973). Introductory rural sociology. New York, John Wilex and Sons.
2. Desai, A.R. (1978). Rural sociology in India. Bombay, Popular Prakashan, 5th Rev.ed.
3. Doshi,S.L. (2007). Rural sociology. Delhi Rawat Publishers.
4. Jayapalan, N. (2002). Rural sociology. New Delhi, Altanic Publishers.
5. Sharma, K.L. (1997). Rural society in India. Delhi, Rawat Publishers

SOC 202	HUMAN ETHICS (For B.Tech. Biotechnology)	1 (1+0)	SEM IV

Objectives

1. To study the meaning and concepts of human behaviour
2. To study human ethical values
3. To study spirituality and attitude
4. To study the methods of stress management

Theory

Universal human aspirations, happiness, and prosperity. Human values and ethics: concept, definition, significance, and sources. Fundamental values: right conduct, peace, truth, love, and non-violence. Ethics: professional, environmental, and ICT. Sensitisation towards others, particularly senior citizens, the developmentally challenged, and gender.

Spirituality, positive attitude and scientific temper. Teamwork and volunteering. Rights and responsibilities. Road safety, Human relations, and family harmony. Modern challenges and value conflict. Sensitization against drug abuse and other social evils. Developing personal code of conduct (SWOT Analysis). Management of anger and stress.

Suggested Readings

1. Gaur RR, Sangal R and Bagaria GP, 2011, A Foundation Course in Human Values and Professional Ethics, Excel Books.
2. Mathur SS, 2010, Education for Values, Environment and Human Rights, RSA International.
3. Sharma RA, 2011, Human Values and Education -Axiology, Inculcation and Research, R. Lall Book Depot.
4. Sharma RP and Sharma M, 2011, Value Education and Professional Ethics, Kanishka Publishers.
5. Srivastava S, 2011, Human Values and Professional Ethics, S K Kataria and Sons.
6. Srivastava S, 2011, Environmental Science, S K Kataria and Sons.
7. Tripathi, A. N., 2009, Human Values, New Age International (P) Ltd, Publishers.

CENTRE OF FOOD SCIENCE AND TECHNOLOGY

Course No.	Course Title	Credits	Semester
FST 301	Food Science and Processing (For B.Tech. Biotechnology)	3 (2+1)	VI
FST 401	Food Safety and Standards (For B.Sc. (Hons.) Agriculture)	4 (3+1)	VII
FST 402	Food Science and Nutrition (For B.Sc. (Hons.) Agriculture)	4 (3+1)	VII
	Total Credits	**11 (8+3)**	

FST 301	**FOOD SCIENCE AND PROCESSING (For B.Tech. Biotechnology)**	**3 (2+1)**	**SEM VI**

Objectives

1. To study food and nutrition for good health
2. To study food spoilage, processing and preservation
3. To study the methods of assessing physical and chemical qualities

Theory

Food and nutrition; Food production and consumption trends in India; Food groups and concept of balanced diet, RDA, biotoxins, antinutritional factors and secondary metabolites; Major deficiencies of calories, proteins, vitamins and micronutrients; Causes of food spoilage; Principles of processing and preservation of food by heat, low temperature, drying and dehydration, chemicals and fermentation; Preservation through ultraviolet and ionizing radiations; Postharvest handing and processing technology of fruits, vegetables, cereals, oilseeds, milk, meat and poultry; Food safety, adulteration, HACCP and Indian food laws; Status of food industry in India.

Practical

Physical and chemical quality assessment of cereals, fruits, vegetables, egg, meat and poultry; Value added products from cereals, millets, fruits, vegetables, milk, egg and meat; Visit to local processing units.

Suggested Readings

1. Gopalan, C., Rama Sastri, B.V. and Bala Subramanian, S.C. (2005). *Nutritive Value of Indian Foods*. NIN, ICMR, Hyderabad.
2. ICAR. (2013). *Handbook of Agricultural Engineering*. ICAR Publications, New Delhi
3. Manay, S. & Shadaksharaswamy, M. (2020). *Foods Facts and Principles*. New Age International Publishers.
4. Srivastava, R.P. and Kumar, S. (2019). *Fruit and Vegetable Preservation-Principles and Practices*, CBS Publishers.
5. www.fassi.gov.in

FST 401	FOOD SAFETY AND STANDARDS (For B.Sc. (Hons.) Agriculture)	4 (3+1)	SEM VII

Objectives

1. To know hazards and understand to protect food from contamination
2. To understand the need for food safety systems
3. To use the scientific approach and practices towards safety

Theory

Food safety: definition, importance and factors affecting food safety; recent concerns- new and emerging pathogens, recent outbreaks; hazards- types (physical, chemical, biological), sources of contamination, management of hazards/contaminations- need and control of parameters: temperature, production design, packaging and food storage; hygiene and sanitation- personal hygiene, food establishments and surface sanitation; pest and rodent control; water- hygiene and quality standards; waste disposal; food safety measures: food safety management systems- basic concepts, components, need and newer approaches to food safety; risk analysis; PRPs- GHPs, GMPs, SSOPs, etc.; HACCP and TQM; GFSI; Food laws and standards: Indian food regulatory regime- FSSA; global scenario- CAC, WTO, SPS, TBT, etc.; other laws and standards related to food- ISO series; Indian and International standards for food products; product labelling and nutritional labelling, organic foods.

Practical

Quality attributes of raw and processed foods, water quality analysis; assessment of surface sanitation by swab/rinse method; personal hygiene; process flow for food establishment; GHP and GMP in a food factory; FSMS: hazard identification and risk analysis; OPRPs. development of HACCP plan; understand the ISO 22000; organizational structure of FSSAI and CAC; design a label for food product.

Suggested Readings

1. Deshpande, H.W. & Katke, S.D. 2021. Food Quality, Assurance and Certification.
2. Fernandes, C. *Safe Food Handling: HACCP Booklet for Food Handlers*, Notion Press.
3. Fortin, N.D. 2009. Food Regulation. John Wiley & Sons, New Jersey.
4. Khatekar, D. & Sarkate, N. 2023. *Handbook of Food Safety*, Step Up Academy.
5. Mathur, P. 2018. *Food Safety and Quality Control*, The Orient Blackswan.
6. Sherikar, A.T., Bachhil, V.N. & Thapliyal, D.C. 2013. *Textbook of Elements of Veterinary Public Health*. ICAR.

FST 402	FOOD SCIENCE AND NUTRITION (For B.Sc. (Hons.) Agriculture)	4 (3+1)	SEM VII

Objectives

To impart knowledge on the biochemical aspects of various nutrients and its interactions in food during processing, storage and deterioration

Theory

Introduction on fundamentals of food science and human nutrition; food- sources and its functions; basic food groups; concept of balanced diets; nutritional requirements and recommended daily allowances (RDA); malnutrition- over and under nutrition and nutritional disorders; water in foods, properties and water activity; major food constituents-carbohydrates, proteins, fats- sources, classification, functions, physico-chemical and nutritional characteristics; effect of processing; digestion, absorption, transport and metabolism in human system; vitamins and minerals- classification, dietary sources, functions, deficiency diseases and effect of processing; anti-nutritional factors; postharvest storage and losses during processing; food spoilage; enzymes in food industry; food additives.

Practical

Standard solutions and buffers; TSS; pH; acidity; water activity; proximate analysis of foods; calorific value of foods, estimation of vitamins, phenols, flavonoids, carotenoids, anti-nutrients in food stuff

Suggested Readings

1. De Man, J.M. 1976. *Principles of Food Chemistry*. AVI.
2. Gibney M.J., Lanham-New S.A., Cassidy, A. & Voster, H.H. (ed.) 2009. *Introduction to Human Nutrition*. Wiley-Blackwell
3. Gopalan, C., Rama Sastri, B.V. & Bala Subramanian, S.C. 2021. *Nutritive Value of Indian Foods*, NIN, ICMR, Hyderabad.
4. Kumar, D. 2019. *Food Science and Nutrition*, Random Publications.
5. Manay, N.S. & Shadaksharaswamy, M. 2020. *Foods Facts and Principles*, New Age International Publishers.
6. Mudambi, R.S. & Rao, S. 1985. *Food Science*, Wiley Eastern Ltd.
7. Rekhi, T. and Yadav, H. 2014. *Fundamentals of Food and Nutrition*. Elite Publishing House.
8. Swaminathan, M. 1999. *Essentials of Foods and Nutrition*, Vol. I. The Bangalore Printing and Publishing Co. Ltd., Bangalore.
9. Trueman, P. 2007. *Nutritional Biochemistry*, MJP Publishers

DIRECTORATE OF STUDENTS' WELFARE


Chaudhary Charan Singh Haryana Agricultural University, Hisar
NATIONAL SERVICE SCHEME
NATIONAL INTEGRATION CAMP
October 23-29, 2024
Youth for my Bharat
Dr. M.L. Khichar
Prof. B.R. Kamboj
Sh. Randhir Panihar
M.L.A., NALWA
Dr. Dinesh Kumar
State NSS Officer


Chaudhary Charan Singh Haryana Agricultural University, Hisar
NATIONAL SERVICE SCHEME


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DIRECTORATE OF STUDENTS' WELFARE

Course No.	Course Title	Credits	Semester
NCC I/ NSS I (AEC)	National Cadet Corps I/ National Service Scheme I	2 (0+2)	I
NCC II/ NSS II (AEC)	National Cadet Corps II/ National Service Scheme II	2 (0+2)	II
CCA 102	Co-curricular Activity	1 (0+1) NG	II
CCA 201 (AEC)	Physical Education, First Aid, Yoga Practices and Cultural Activities	2 (0+2)	III
NCC III/ NSS III	National Cadet Corps III/ National Service Scheme III	2 (0+2) NG	III
CCA 202	Co-curricular Activity	1 (0+1) NG	IV
NCC IV/ NSS IV	National Cadet Corps IV/ National Service Scheme IV	2 (0+2) NG	V
	Total Credits	**6 (0+6)**	

NCC I/ NSS I (AEC)	NATIONAL CADET CORPS I/ NATIONAL SERVICE SCHEME I	2 (0+2)	SEM I

National Cadet Corps (NCC I)

Objectives

1. To develop qualities of character, courage, comradeship, discipline, leadership, secular outlook, spirit of adventure and sportsmanship and the ideals of selfless service among the youth to make them useful citizen.
2. To create a human resource of organized trained and motivated youth to provide leadership in all walks of life including the Armed Forces and be always available for the service of the nation.

Practical/ Awareness programmes

- Aims, objectives, organization of NCC and NCC song. DG's cardinals of discipline.
- Drill- aim, general words of command, attention, stands at ease, stand easy and turning.
- Sizing, numbering, forming in three ranks, open and close order march, and dressing.
- Saluting at the halt, getting on parade, dismissing, and falling out.
- Marching, length of pace, and time of marching in quick/slow time and halt. Side pace, pace forward and to the rear. Turning on the march and wheeling. Saluting on the march.
- Marking time, forward march, and halt. Changing step, formation of squad and squad drill.
- Command and control, organization, badges of rank, honors, and awards
- Nation Building- cultural heritage, religions, traditions, and customs of India. National integration. Values and ethics, perception, communication, motivation, decision making, discipline and duties of good citizens. Leadership traits, types of leadership. Character/ personality development. Civil defense organization, types of emergencies, firefighting, protection. Maintenance of essential services, disaster management, aid during development projects.

- Basics of social service, weaker sections of society and their needs, NGO's and their contribution, contribution of youth towards social welfare and family planning.
- Structure and function of human body, diet and exercise, hygiene and sanitation. Preventable diseases including AIDS, safe blood donation, first aid, physical and mental health. Adventure activities. Basic principles of ecology, environmental conservation, pollution and its control.

As per government guidelines, for getting B and C certificate in NCC, minimum years of requirement is 2 and 3 years, respectively along with 1-2 annual camps.

National Service Scheme (NSS I)

Objective

1. Evoking social consciousness among students through various activities viz., working together, constructive, and creative social work, to be skilful in executing democratic leadership, developing skill in programme, to be able to seek self-employment, reducing gap between educated and uneducated, increasing awareness and desire to help sections of society.

Practical/ Awareness programmes

- Orientation: history, objectives, principles, symbol, badge; regular programs under NSS
- Organizational structure of NSS, Code of conduct for NSS volunteers, points to be considered by NSS volunteers' awareness about health.
- NSS program activities: Concept of regular activities, special camping, day camps, basis of adoption of village/slums, conducting survey, analyzing guiding financial patterns of scheme, youth program/ schemes of GOI, coordination with different agencies and maintenance of diary. Understanding youth. Definition, profile, categories, issues and challenges of youth; and opportunities for youth who is agent of the social change.
- Community mobilization: Mapping of community stakeholders, designing the message as per problems and their culture; identifying methods of mobilization involving youth-adult partnership. Social harmony and national integration.
- Indian history and culture, role of youth in nation building, conflict resolution and peacebuilding. Volunteerism and shramdaan. Indian tradition of volunteerism, its need, importance, motivation, and constraints; shaman as part of volunteerism.
- Citizenship, constitution, and human rights: Basic features of constitution of India, fundamental rights and duties, human rights, consumer awareness and rights and rights to information. Family and society. Concept of family, community (PRIs and other community-based organizations) and society.

A student enrolled in NSS course should put in at least 60 hours of social work in different activities in a semester other than five regular one-day camp in a year and one special camp for duration of 7 days at any semester break period in the two years. Different activities will include orientation lectures and practical works. Activities directed by the Central and State Government have to be performed by all the volunteers of NSS as per direction.

NCC II/ NSS II (AEC)	NATIONAL CADET CORPS II/ NATIONAL SERVICE SCHEME II	2 (0+2)	SEM II

National Cadet Corps (NCC II)

Objective

1. To develop qualities of character, courage, comradeship, discipline, leadership, secular outlook, spirit of adventure and sportsmanship and the ideals of selfless service among the youth to make them useful citizen.
2. To create a human resource of organized trained and motivated youth to provide leadership in all walks of life including the Armed Forces and be always available for the service of the nation.

Practical/ Awareness programmes

- Arms Drill-Attention, stand at ease, stand easy. Getting on parade. Dismissing and falling out. Ground/take up arms, examine arms. Shoulder from the order and vice-versa, present from the order and vice-versa. Saluting at the shoulder at the halt and on the march. Short/ long trail from the order and vice- versa. Guard mounting, guard of honor, Platoon/Coy Drill.
- Characteristics of rifle (.22/.303/SLR), ammunition, fire power, stripping, assembling, care, cleaning, and sight setting. Loading, cocking, and unloading. The lying position and holding.
- Trigger control and firing a shot. Range Procedure and safety precautions. Aiming and alteration of sight. Theory of groups and snap shooting. Firing at moving targets. Miniature range firing. Characteristics of Carbine and LMG.
- Introduction to map, scales, and conventional signs. Topographical forms and technical terms.
- The grid system. Relief, contours, and gradients. Cardinal points and finding north. Types of bearings and use of service protractor. Prismatic compass and its use. Setting a map, finding north and own position. Map to ground and ground to map. Knots and lashings, Camouflage and concealment, Explosives and IEDs.
- Field defenses obstacles, mines and mine lying. Bridging, waterman ship. Field water supplies, tracks and their construction. Judging distance. Description of ground and indication of landmarks. Recognition and description of target. Observation and concealment. Field signals. Section formations. Fire control orders. Fire and movement. Movement with/without arms. Section battle drill. Types of communication, media, latest trends and developments.

National Service Scheme (NSS II)

Objective

1. To evoke social consciousness among students through various activities viz., working together, constructive, and creative social work, to be skillful in executing democratic leadership, developing skill in programme, to be able to seek self-employment, reducing gap between educated and uneducated, increasing awareness and desire to help sections of society.

Practical/ Awareness programmes

- Importance and role of youth leadership
- Meaning, types and traits of leadership, qualities of good leaders; importance and roles of youth leadership, Life competencies
- Definition and importance of life competencies, problem-solving and decision-making interpersonal communication. Youth development programs
- Development of youth programs and policy at the national level, state level and voluntary sector; youth-focused and youth-led organizations
- Health, hygiene and sanitation. Definition needs and scope of health education; role of food, nutrition, safe drinking water, water borne diseases and sanitation (Swachh Bharat Abhiyan) for health; national health programs and reproductive health. Youth health, lifestyle, HIV AIDS and first aid. Healthy lifestyles, HIV AIDS, drugs and substance abuse, home nursing and first aid. Youth and yoga. History, philosophy, concept, myths, and misconceptions about yoga; yoga traditions and its impacts, yoga as a tool for healthy lifestyle, preventive and curative method.

CCA 201 (AEC)	**PHYSICAL EDUCATION, FIRST AID, YOGA PRACTICES AND CULTURAL ACTIVITIES**	**2 (0+2)**	**SEM III**

Objectives

1. To make the students aware about Physical Education, First Aid and Yoga Practices
2. To disseminate the knowledge and skill how to perform physical training, perform first aid and increase stamina and general wellbeing through yoga

Practical

Physical education; Training and Coaching - Meaning and Concept; Methods of Training; aerobic and aerobic exercises; Calisthenics, weight training, circuit training, interval training, Fartlek training; Effects of Exercise on Muscular, Respiratory, Circulatory and 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 and its Management; Posture; Postural Deformities; Exercises for good posture.

Yoga; History of Yog, Types of Yog, Introduction to Yog,

- Asanas (Definition and Importance) Padmasan,san, Vajrajasan, Shashankasan, Pashchimotasan, Ushtrasan, Tadasan, Padhastasan, Ardhchandrasan, Bhujangasan, Utanpadasan, Sarvangasan, Parvatasan, Patangasan, Shishupalanasan – left leg-right leg, Pavanmuktasan, Halasan, Sarpasan, Ardhdhanurasan, Sawasan
- Suryanamskar Pranayama (Definition and Importance) Omkar, Suryabhedan, Chandrabhedan, AnulomVilom, Shitali, Shitkari, Bhastrika, Bhramari
- Meditation (Definition and Importance), Yogic Kriyas (Kapalbhati), Tratak, Jalneti and Tribandh

- Mudras (Definition and Importance) Gyanmudra, Dhyanmudra, Vayumudra, Akashmudra, Pruthvimudra, Shunyamudra, Suryamudra, Varunmudra, Pranmudra, Apanmudra, Vyanmudra, Uddanmudra
- Role of yoga in sports
- Teaching of Asanas – demonstration, practice, correction and practice.

History of sports and ancient games, Governance of sports in India; Important national sporting events; Awards in Sports; History, latest rules, measurements of playfield, specifications of equipment, 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 equipment and upkeep. First aid Techniques, First aid related with Respiratory system. First aid related with Heart, Blood and Circulation. First aid related with Wounds and Injuries. First aid related with Bones, Joints Muscle related injuries. First aid related with Nervous system and Unconsciousness. First aid related with Gastrointestinal Tract. First aid related with Skin, Burns. First aid related with Poisoning. First aid related with Bites and Stings. First aid related with Sense organs, Handling and transport of injured traumatized persons. Sports injuries and their treatments.

Music- Importance of Music in life, rhythm in music, role of music in personality development, naad, swar, shruti, alankar, gamak, vadi-samvadi, in music. Importance of expression, Dance and Meditation.

Dramatics- History and theory of theatre. Acting, directing, stage design craft of script and dialogue

Haryana Folk Lore and Culture- Society and Folk Lore, Historical context, folk music in different regions, instruments used in Haryana Folk Lore, Singing style of different folk gharanas.

COMMITTEE FOR FINALISATION OF UG COURSE CURRICULUM