

Minimum Credit Requirement		
SN	Subject	Doctoral Programme
1	Major	15
2	Minor	8
3	Supporting	5
4	Seminar	2
5	Research	45
6	Total Credits	75
7	Compulsory Non Credit Courses	See relevant section

Common Supporting Course			
CODE	COURSE TITLE	CREDITS	
STM 601	ADVANCED STATISTICAL METHODS	2+1	1st year I-Semester
STM 602	SOFTWARE FOR FISHERIES DATA ANALYSIS AND MANAGEMENT	0+2	1st year II-Semester

Define Major, Minor Course	
Major subject:	The subject (department) in which the students takes admission
Minor subject:	The subject closely related to students major subject (e.g., if the major subject is Entomology, the appropriate minor subjects should be Plant Pathology & Nematology).
Supporting subject:	The subject not related to the major subject. It could be any subject considered relevant for student's research work.
Non-Credit Compulsory Courses:	Please see the relevant section for details. Six courses (PGS 501-PGS 506) are of general nature and are compulsory for Master's programme. Ph. D. students may be exempted from these courses if already studied during Master's degree.

COMPULSORY NON-CREDIT COURSES		
(Compulsory for Master's programme in all disciplines; Optional for Ph.D. scholars)		
CODE	COURSE TITLE	CREDITS
PGS 501	LIBRARY AND INFORMATION SERVICES	0+1
PGS 502	TECHNICAL WRITING AND COMMUNICATIONS SKILLS	0+1
PGS 503 (e-Course)	INTELLECTUAL PROPERTY AND ITS MANAGEMENT IN AGRICULTURE	1+0
PGS 504	BASIC CONCEPTS IN LABORATORY TECHNIQUES	0+1
PGS 505 (e-Course)	AGRICULTURAL RESEARCH, RESEARCH ETHICS AND RURAL DEVELOPMENT PROGRAMMES	1+0
PGS 506 (e-Course)	DISASTER MANAGEMENT	1+0

Compulsory Non-Credit Courses	
PGS 501 LIBRARY AND INFORMATION SERVICES 0+1 Objective	
To equip the library users with skills to trace information from libraries efficiently, to apprise them of information and knowledge resources, to carry out literature survey, to formulate information search strategies, and to use modern tools (Internet, OPAC, search engines etc.) of information search.	
Practical	Introduction to library and its services; Role of libraries in education, research and technology transfer; Classification systems and organization of library; Sources of information- Primary Sources, Secondary Sources and Tertiary Sources; Intricacies of abstracting and indexing services (Science Citation Index, Biological Abstracts, Chemical Abstracts, CABI Abstracts, etc.); Tracing information from reference sources; Literature survey; Citation techniques/Preparation of bibliography; Use of CD-ROM Databases, Online Public Access Catalogue and other computerized library services; Use of Internet including search engines and its resources; e-resources access methods.
PGS 502 TECHNICAL WRITING AND COMMUNICATIONS SKILLS 0+1 Objective	
To equip the students/scholars with skills to write dissertations, research papers, etc. To equip the students/scholars with skills to communicate and articulate in English (verbal as well as writing).	

Practical	<p>Technical Writing -Various forms of scientific writings- theses, technical papers, reviews, manuals, etc; Various parts of thesis and research communications (title page, authorship contents page, preface, introduction, review of literature, material and methods, experimental results and discussion); Writing of abstracts, summaries, précis, citations etc.; commonly used abbreviations in the theses and research communications; illustrations, photographs and drawings with suitable captions; pagination, numbering of tables and illustrations; Writing of numbers and dates in scientific write-ups; Editing and proof-reading; Writing of a review article.</p> <p>Communication Skills -Grammar (Tenses, parts of speech, clauses, punctuation marks); Error analysis (Common errors); Concord; Collocation; Phonetic symbols and transcription; Accentual pattern: Weak forms in connected speech: Participation in group discussion: Facing an interview; presentation of scientific papers.</p>
PGS 503 INTELLECTUAL PROPERTY AND ITS 1+0 (e-Course) MANAGEMENT IN AGRICULTURE Objective	
<p>The main objective of this course is to equip students and stakeholders with knowledge of intellectual property rights (IPR) related protection systems, their significance and use of IPR as a tool for wealth and value creation in a knowledge-based economy.</p>	
Theory	<p>Historical perspectives and need for the introduction of Intellectual Property Right regime; TRIPs and various provisions in TRIPS Agreement; Intellectual Property and Intellectual Property Rights (IPR), benefits of securing IPRs; Indian Legislations for the protection of various types of Intellectual Properties; Fundamentals of patents, copyrights, geographical indications, designs and layout, trade secrets and traditional knowledge, trademarks, protection of plant varieties and farmers' rights and bio-diversity protection; Protectable subject matters, protection in biotechnology, protection of other biological materials, ownership and period of protection; National Biodiversity protection initiatives; Convention on Biological Diversity; International Treaty on Plant Genetic Resources for Food and Agriculture; Licensing of technologies, Material transfer agreements, Research collaboration Agreement, License Agreement.</p>
PGS 504 BASIC CONCEPTS IN LABORATORY TECHNIQUES 0+1 Objective	
<p>To acquaint the students on the basics of commonly used techniques in laboratory.</p>	
Practical	<p>Safety measures while in Lab; Handling of chemical substances; Use of burettes, pipettes, measuring cylinders, flasks, separatory funnel, condensers, micropipettes and vaccumets; washing, drying and sterilization of glassware; Drying of solvents/chemicals. Weighing and preparation of solutions of different strengths and their dilution; Handling techniques of solutions; Preparation of different agro-chemical doses in field and pot applications; Preparation of solutions of acids; Neutralisation of acid and bases; Preparation of buffers of different strengths and pH values. Use and handling of microscope, laminar flow, vacuum pumps, viscometer, thermometer, magnetic stirrer, micro-ovens, incubators, sandbath, waterbath, oilbath; Electric wiring and earthing. Preparation of media and methods of sterilization; Seed viability testing, testing of pollen viability; Tissue culture of crop plants; Description of flowering plants in botanical terms in relation to</p>
PGS 505 AGRICULTURAL RESEARCH, RESEARCH ETHICS 1+0 (e-Course) AND RURAL DEVELOPMENT PROGRAMMES Objective	

To enlighten the students about the organization and functioning of agricultural research systems at national and international levels, research ethics, and rural development programmes and policies of Government.

Theory	UNIT I History of agriculture in brief; Global agricultural research system: need, scope, opportunities; Role in promoting food security, reducing poverty and protecting the environment; National Agricultural Research Systems (NARS) and Regional Agricultural Research Institutions; Consultative Group on International Agricultural Research (CGIAR): International Agricultural Research Centres (IARC), partnership with NARS, role as a partner in the global agricultural research system, strengthening capacities at national and regional levels; International fellowships for scientific mobility.
	UNIT II Research ethics: research integrity, research safety in laboratories, welfare of animals used in research, computer ethics, standards and problems in research ethics.
	UNIT III Concept and connotations of rural development, rural development policies and strategies. Rural development programmes: Community Development Programme, Intensive Agricultural District Programme, Special group – Area Specific Programme, Integrated Rural Development Programme (IRDP) Panchayati Raj Institutions, Co-operatives, Voluntary Agencies/Non-Governmental Organisations. Critical evaluation of rural development policies and programmes. Constraints in implementation of rural policies and programmes.

PGS 506 DISASTER MANAGEMENT 1+0 (e-Course) Objectives

To introduce learners to the key concepts and practices of natural disaster management; to equip them to conduct thorough assessment of hazards, and risks vulnerability and capacity building.

Theory	UNIT I Natural Disasters- Meaning and nature of natural disasters, their types and effects. Floods, Drought, Cyclone, Earthquakes, Landslides, Avalanches, Volcanic eruptions, Heat and cold Waves, Climatic Change: Global warming, Sea Level rise, Ozone Depletion
	UNIT II Man Made Disasters- Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire. Oil fire, air pollution, water pollution, deforestation, Industrial wastewater pollution, road accidents, rail accidents, air accidents, sea accidents.
	UNIT III Disaster Management- Efforts to mitigate natural disasters at national and global levels. International Strategy for Disaster reduction. Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, Community-based organizations, and media. Central, State, District and local Administration; Armed forces in Disaster response; Disaster response: Police and other organizations.

Supporting Course

STM 601 ADVANCED STATISTICAL METHODS 2+1 Objective

To expose the students to advanced statistical methods and hands on training in the analysis of data using statistical software.

Theory	UNIT I Introduction to matrix algebra, Bayes’ theorem and its application, mathematical expectation.
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	UNIT II Probability distribution: Negative, Binomial, Hyper-geometric and Exponential and their application in fisheries; Multivariate normal distribution; Multiple and Partial correlation and regression.
	UNIT III Multivariate ANOVA; Likelihood Methods; Concept of Principal component analysis; Canonical correlation and Path coefficients; Discriminant analysis; Factor analysis and Cluster analysis; Transformations; Analysis of Covariance.
	UNIT IV Linear programming: Objective function, graphical solution of linear programming problem, Simplex method.
	UNIT V Non parametric test: Wilcoxon test, Mann-Whitney U-test, Kruskal and Wallis test and Friedman's test; Use of computer software for data analysis; Survival analysis.
Practical	Exercises on Bayes' theorem; Negative, Binomial distribution; Hyper-geometric distributions; Exponential distribution; Multiple and partial correlation and regression analysis; Principal component analysis; Canonical correlation and path coefficients; Discriminant analysis; Factor analysis and Cluster analysis; Transformations; Covariance analysis; Wilcoxon test, Mann-Whitney test, Kruskal and Wallis test and Friedman's test and linear programming; Use of computer software.
STM 602 SOFTWARE FOR FISHERIES DATA 0+2 ANALYSIS AND MANAGEMENT	
Objective	
To provide hands on training on the use of various statistical packages in data analysis.	
Practical	Introduction to computer software: SPSS, SAS, SYSTAT and STATISTICA for analysis and presentation of fisheries data; Basic concepts of database management systems; Introduction to MS-ACCESS, ORACLE (RDBMS); Exercises on analysis of data using MS-EXCEL, SPSS, SAS, FISAT, SYSTAT and STATISTICA; Creation of Database using MS-ACCESS, ORACLE.

AQUATIC ANIMAL HEALTH Course Structure - at a Glance		
CODE	COURSE TITLE	CREDITS
AAH 601**	FISH AND SHELLFISH VIROLOGY	2+1
AAH 602**	ADVANCES IN PARASITOLOGY	2+1
AAH 603**	MOLECULAR MECHANISMS IN DISEASE PROCESS	2+1
AAH 604	CRUSTACEAN PATHOLOGY	1+1
AAH 605	FISH PHARMACOLOGY	2+1
AAH 606	BIOTECHNOLOGICAL TOOLS IN DISEASE DIAGNOSIS	1+1

AAH 607	PUBLIC HEALTH MICROBIOLOGY AND EPIDEMIOLOGY	2+1
AAH 608	MOLECULAR TECHNIQUES IN MICROBIOLOGY	1+1
AAH 609	FISH MYCOLOGY AND VIROLOGY	1+1
AAH 691	DOCTORAL SEMINAR I	1+0
AAH 692	DOCTORAL SEMINAR II	1+0
AAH 699	DOCTORAL RESEARCH	45

**** Compulsory for Doctoral programme**

AAH 601 FISH AND SHELLFISH VIROLOGY 2+1 Objective	
To understand the etiology and pathogenesis of common fish and shell fish viral diseases.	
Theory	UNIT I Molecular virology and pathogenesis of selected viruses infecting fish and shellfish such as IPN, VHS, IHN, VHS.
	UNIT II Nodavirus infection of fish and freshwater prawns, WSSV, YHV.
	UNIT III Antiviral drugs, viral vaccines, emerging viruses and evolution of new viruses.
Practical	Molecular detection and sequence analysis of fish/shellfish viruses; Collection and analysis of molecular information of various viruses using sequence information available in public domain.

AAH 602 ADVANCES IN PARASITOLOGY 2+1 Objective	
To understand the pathobiology of parasitic infection in fishes.	
Theory	UNIT I Environmental parasitology: Macro-environmental and micro-environmental influence on parasite incidence.
	UNIT II Host parasite interaction: Pathological changes induced in host due to parasitic infection.
	UNIT III Molecular parasitology; Parasite biochemistry.
	UNIT IV Evolution of parasites; Hyperparasitism.
	UNIT V Antiparasitic drugs applied in aquaculture and their action.
	UNIT VI Parasitic immunity.
Practical	Isolation techniques of parasites. Molecular characterization of parasites. Use of molecular probes for identification of parasites and tracking life stages of

AAH 603 MOLECULAR MECHANISMS IN DISEASE PROCESS 2+1 Objective	
To understand the molecular mechanism of common diseases and methods for studying them.	
Theory	UNIT I Uptake of macromolecules by cells. Viral gene expression. Channelising the cellular events to study the cell viability, cell proliferation, cell lineage.

	UNIT II Biological performance of each cell, i.e., changes in mitochondrial junction, morphology, Ca ⁺ metabolism, vesicle trafficking; membrane transport system; protein molecule dynamics and expression profile of each cell.
	UNIT III RNA interfering mechanisms.
Practical	FISH technique, TUNEL assay, MTT assay, NO assay, COMET assay to detect apoptosis. FRET and FRAP microscopy techniques.

AAH 604 CRUSTACEAN PATHOLOGY 2+1 Objective	
To understand the microscopic pathology associated with various diseases of crustaceans.	
Theory	UNIT I Normal histology of different organs of crustaceans with special reference to penaeid shrimp.
	UNIT II Major pathogens of commercially important cultured crustaceans with special reference to shrimp and freshwater prawn pathogens: viral, bacterial, fungal and parasites.
	UNIT III Biology, morphology, diagnostic methods, clinical signs and symptoms and pathological changes associated with these pathogens.
	UNIT IV Bacterial diseases: Vibriosis; necrotizing hepatopancreatitis, rickettsial diseases, mycobacteriosis.
	UNIT V Fungal diseases: Larval mycosis, fusarium disease; Parasitic diseases: Microsporidians, Haplosporidians, Ciliates, Cephaline gregarines. Diseases of non infectious etiology: gas bubble disease, hemocytic enteritis.
Practical	Detailed study on normal histology of different organs/tissues of crustaceans. Diagnostic procedures: field level diagnostic methods (direct microscopic observation, tissue impression, smear and routine staining methods); Histopathology of different diseases of crustaceans. Serological methods; Electron microscopy; Gene probe and dot blot assay; In-situ hybridization (ISH) and polymerase chain reaction (PCR).

AAH 605 FISH PHARMACOLOGY 2+1 Objective	
To understand the principles and application of pharmacodynamic compounds applied in aquaculture. To elucidate the pharmacodynamics of important chemicals/drugs applied in aquaculture.	
Theory	UNIT I Introduction to pharmacology, pharmacological terms and definitions, sources of drugs.
	UNIT II Principles of drug activity, pharmacokinetics. Absorption, distribution, biotransformation and excretion of drugs.
	UNIT III Pharmacodynamics, concept of drug receptor, dose response relationship, half-life and withdrawal period, factors affecting drug effect and dosage, principles of drug safety in terms of species and environment.
Practical	Antibiogram preparations; Antibiotic residual assays; Studies on histopathological changes caused due to chemotherapy. Important anesthetics

AAH 606 BIOTECHNOLOGICAL TOOLS IN DISEASE DIAGNOSIS 1+1 Objective	
To understand the principles and applications of different biotechnological tools used for disease diagnosis.	
Theory	UNIT I Advances in disease diagnostic procedures in aquaculture.

	UNIT II Molecular diagnostic methods such as in situ hybridization, nucleic acid probe-based diagnosis; Choice and characteristics of probe, Probe labeling.
	UNIT III Hybridization: Hybridization strategies, factors affecting the rate of hybridization, Immobilization of nucleic acid on filters. Types of hybridization: Southern, Northern, Dot/Slot blot hybridization.
	UNIT IV Various types of polymerase chain reaction (PCR) such as conventional one step, nested and semi-nested PCR, RT-PCR, real-time PCR; LAMP.
	UNIT V DNA Microarrays: DNA chips, preparations of DNA arrays, label and applications; other related molecular techniques.
	UNIT VI Monoclonal antibody-based diagnostics.
Practical	Nucleic acid extraction, PCR detection of various pathogens. Monoclonal antibody-based diagnostic application. Protein profiling, DNA fingerprinting.
AAH 607 PUBLIC HEALTH MICROBIOLOGY AND 2+1 EPIDEMIOLOGY	
To learn the zoonotic importance of fish pathogens and toxins produced by aquatic organisms.	
Theory	UNIT I Introduction to food-borne diseases – Classification; food-borne infection and intoxication- microorganisms important in food borne diseases and food toxicity – economic importance of food - borne illness.
	UNIT II Factors influencing food-borne disease outbreaks; Sources and transmission of pathogens in foods: human, animal, and environmental reservoirs; crosscontamination; food associations; Microbial detection and indicator organisms: approach and techniques; pathogen indicators; bacteria responsible for food borne infection and intoxication; bacterial toxin and miscellaneous toxic factors; factors affecting toxin production in foods; fungal toxins, aflatoxin, ochratoxin and other fungal toxins; factors affecting fungal toxin production in food; marine toxins PSP, ASP, NSP, ciguatera poisoning and other marine toxins; histamines and other bioamines toxicity.
	UNIT III Zoonoses: Zoonoses of different origins – rare, new, and emerging zoonoses; trematode, cestode and nematode zoonoses; food borne viruses; prevention and control of food toxicity and food-borne diseases. Government Agency and Food Safety Policy: HACCP, Risk Assessment, New pathogens and emerging food borne diseases. Current Food Safety Topic: antibiotic resistance.
Practical	Isolation and identification of toxin producing microorganisms and other potent human pathogens in fish and fishery products – detection of toxins using biological and immunological techniques.

AAH 608 MOLECULAR TECHNIQUES IN MICROBIOLOGY 1+1 Objective	
To understand the molecular techniques used in genetic manipulation.	
Theory	UNIT I Techniques for isolation of DNA for gram positive bacteria, gram negative bacteria, fungal cells, animals cells, DNA detection, purification, quantification. Plasmid DNA and techniques for isolation and purification of
	UNIT II Determination of G+C content of DNA: Chromatographic technique, spectro photometric method, isopycnic bouyant density gradient centrifugation.
	UNIT III Restriction fragment length polymorphism: Different types of restriction enzymes, their target sites, digestion patterns, chromosomal DNA-RFLP, plasmid DNA, PCR-RFLP, Pulsefield gel electrophoresis and its applications.
	UNIT IV Methods of gene transfer: Transformation, plasmid DNA as cloning vectors, electroporation.

	UNIT V Gene transfer by conjugation: Conjugative plasmids and their application in recombinant DNA technology Gene transfer by transduction: application of bacteriophages in cloning.
Practical	Isolation of DNA and RNA; Quantification of DNA and RNA, gene amplification, primer designing, gene cloning-restriction digestion, ligation and transformation, gene sequencing, gene expression, immunoblotting, design and application of gene probes.

AAH 609 FISH MYCOLOGY AND VIROLOGY 1+1 Objective	
To study the characteristics of fungal and viral agents causing diseases in fish and shellfish and their control measures.	
Theory	UNIT I Fungi and environment, role of fungi in food processing and aquaculture, the growth of yeasts and molds in fishes – effect of heat, chilling, freezing and chemical preservatives on common fungi associated with fishes. Mycotoxins – source and conditions effecting their production. Techniques for isolation and identification of yeasts and molds.
	UNIT II General properties of viruses. Viruses associated with fishes and water characteristics. Effect of heat and freezing on food-borne viruses. Techniques for cultivation of viruses, tissue culture.
Practical	Isolation and identification of aquatic fungi, fungi involved in food spoilage and diseases, application of fungi, detection of mycotoxins, isolation of viruses using cell culture, molecular identification of viral diseases.