
Fisheries Economics, M. F. Sc. Syllabus

Fisheries Economics,
Extension and
Statistics Division

**Central Institute of
Fisheries Education,
Mumbai-400061**

M.F.Sc (Fisheries Economics) Syllabus
Courses Offered

S. No.	Course No.	Titles	Credits	Minimum Credit Requirements
A Major Core Courses			23 Credits	
1.	FEC 501	Microeconomics	2+1	
2.	FEC 502	Macro Economics	3+0	
3.	FEC 503	Fish Marketing Management	2+1	
4.	FEC504	Economics of Development and Planning	3+0	
5.	FEC 505	Introduction to Econometrics	1+1	
6.	FEC506	Fisheries Finance and Project Management	2+1	
7.	FEC 507	Principles of Economics	2+1	
8.	FEC 508	Indian Economy	2+0	
9.	FEC 509	International Economics And Trade I	1+1	
10.	FEC 510	Environmental Economics I	1+1	
11.	FEC 511	Mathematics for Fisheries Economics	1+1	
12.	FEC 512	Aquaculture production economics	1+1	
13.	FEC 513	GIS and Remote Sensing	1+1	
B MINOR COURSES (Courses outside major discipline / from other relevant disciplines)			9 Credits	
C SUPPORTING COURSES			5 Credits	
1.	FST 501	Research Methodology	1+1	
2.	FST 502	Statistical Methods	1+2	
Total Course Work Credits			37 Credits	
D Masters' Seminar			1 Credits	
	FEC-591	Master Seminar	0+1	
E FIELD TRAINING			2 Credits	
	FEC 551	Field Training / Internship	0+2	
F Master Research			20 Credits	
	FEC 599	Master Research (Semester III)	0+10	
	FEC 599	Master Research (Semester IV)	0+10	
Total Minimum M.F.Sc. Program Credits			60 Credits	

CORE COURSES

FEC 501: MICROECONOMICS

(2+1)

Objective:

- To provide an understanding of principles of economics that applies to decisions of individual consumers and producers within the larger economic system.

Theory:

UNIT I

Basic concepts of economics; micro/macro-economics; positive and normative economics; scarcity and choice; economic systems and thoughts.

UNIT II

Theory of Demand- Consumer Behaviour, Cardinal Utility theory, Indifference Curves theory, Applications of Indifference Curves analysis, Income and Substitution effect, Derivation of demand curve, Consumer surplus, Equilibrium of the consumer, Elasticity of demand - Market demand, Constant elasticity demand function, Distributed lag models of demand, Nerlove's stock adjustment principle, Houthakker's and Taylor's dynamic demand models.

UNIT III

Theory of production, Production functions, Returns to scale, long run analysis of production, Law of variable proportions, Technological progress, Equilibrium of the firm, Choice of optimal combination of factors of production, Derivation of cost function from production function, Production function of a multiproduct firm, ISO-revenue curve of the multiproduct firm, Linear production functions; Theory of costs - Cost curves, Traditional theory of costs, Modern theory of costs, Short and Long run costs, Marginal cost, Minimum Average Total Costs, Analysis of Economies of Scale- Social, Private and accounting costs.

UNIT IV

Market Equilibrium, Behaviour of Firms in Competitive Markets, Perfect Competition, Effect of Taxation and Subsidies on market equilibrium, Monopoly- Monopolistic, Oligopoly, Theory of Factor Markets.

UNIT V

General Equilibrium Theory, Welfare Economics, Pareto Optimality, Social welfare criteria, Social Welfare functions.

Suggested Readings:

1. Henderson, J.M. and Quandt, R.E. 2000. Microeconomic Theory: A Mathematical Approach. McGraw-Hill.
2. Koutsoyiannis, A. 2003. Modern Microeconomics. The Macmillan Press.
3. Varian, Hal R. 1999. Intermediate Microeconomics. Affiliated East-West Press
4. H.L Ahuja, Adv. Micro Economics

Objectives:

- To familiarize the student with the basic concepts and principles of macroeconomics including the relationship between macro variables and implication of the macroeconomic policies.

Theory:**UNIT I**

Nature and Scope of Macro Economics, National Income-National Income Accounting- definition and concepts of NI, different components of national Income, and methods of national income accounting.

UNIT II

Classical Concepts: Classical theory of income and Employment and Say's Law - J.S.Mill – Pigou – Relationship between money and real wages-Role of interest rates in classical framework and equality of saving and investment.

UNIT III

Keynesian concepts: Modern theory of Employment and Effective Demand Theories of consumption, Consumption function, Investment and savings-Concept of Multiplier and Accelerator, Output and Employment - Rate of interest - Classical, Neo classical and Keynesian version, Classical theory Vs Keynesian theories of employment.

UNIT IV

Money- Nature and Function of money, classical theories of Money and Price , Keynesian theory of money and Friedman Restatement theory of money; Supply and Demand for Money.

UNIT V

IS & LM frame work - General Equilibrium of product and money markets, Monetary policy, Fiscal policy, Effectiveness of Monetary and Fiscal policy; Public Finance, Public revenue and taxation- Cannons of taxation and expenditure, concept of economic development and growth, Central banking.

UNIT VI

Inflation- Nature, Effects and control. Business Cycle theory, Credit and Commercial Banking- Recent/ Current developments in monetary and fiscal policies – Introduction to Balance of Payments, Foreign Exchange and Economic stabilizations.

Suggested Readings:

1. Gardner Ackley 1987. *Macro Economic: Theory and Policy*. Collier Macmillan
2. H.L. Ahuja. *Macro economics, Theory and Policy*. S. Chand & Co.

3. David Colander. *Macroeconomics*
4. K. K. Dewett. *Macroeconomics* S.Chand Publishers
5. Samuelson Nordhaus. *Economics*
6. Dornbusch. 2006. *Macroeconomics*, McGraw Hill Publication
7. Eugene A Diulio, 2006. *Macroeconomics*, 4th Ed. Schaums' Outlines.

FEC 503 FISH MARKETING MANAGEMENT

(2+1)

Objectives:

- To impart adequate knowledge and analytical skills in the field of fish marketing and management

Theory:

UNIT I

Fish Marketing- concepts and scope, Classification of markets, Market structure, Conduct and performance, Marketing in a developing economy, Marketing functions and its importance in fish marketing. Marketable & Marketed surplus. Concept and estimation, Demand and supply models; formulation, estimation and projections. Marketing channels and intermediaries and their role, Need for market regulation in the present context, price stabilization measures and policies; forward trading, future markets and commodity boards; channels in marketing, price spread and efficiency; market integration; Problems in marketing of fish and fishery products; government interventions in fish marketing including regulations, co-operative marketing etc.; marketing of inputs.

UNIT II

Indian marketing environment; rural marketing; Fishery & aquaculture marketing system; wholesale and retailing, consumer behaviour; buying process, marketing mix, marketing strategy, market planning, market segmentation, organization, research, extension and rural retailing, International marketing and finance, Direct marketing, Contract farming, Supply Chain and Value Chain Management.

UNIT III

Marketing information system, Role of IT in marketing of fisheries commodities, Market information service - electronic auctions (e-bay), e-Chaupals, Agmarknet, Domestic and Export market Intelligence Cell (DEMIC)- marketing extension.

UNIT IV

Spatial and temporal price relationship, price-forecasting, time-series analysis and models, Price policy and economic development, non-price instruments.

Practicals:

Supply and demand elasticities in relation to problems in fisheries marketing. Identification of market channel, Estimation and analysis of price spread and marketing efficiency of different channels. Marketing structure analysis through concentration ratios. Performance analysis of Regulated markets and marketing societies. Case study in supply chain management ,quantitative estimation of supply chain efficiency. Online searches for market information sources and interpretation of market intelligence reports - Technical Analysis for important fishery commodities-Case study on marketing mix, marketing strategy, segmentation, pricing methods, Case study of consumer behaviours, new product development.

Suggested Readings:

1. Amarchand and Varadharajan, B., *An introduction to marketing*, Vikash Publishing House, New Delhi
2. Dennis Adeock, Ray Brandfield, Al Halborg and C. Ross, *Marketing Principles and Practice*, Pitman Publishing, London.
3. Ian Chaston, *Marketing – In Fisheries and Aquaculture*, Fishing News Books Ltd., England.
4. Jolson, M. A., *Marketing Management*, Macmillan Publishing Inc., New Delhi.
5. Purecell WD & Koontz SR. 1999. *Agricultural Futures and Options: Principles and Strategies*. 2nd Ed. Prentice-Hall.
6. Rhodes VJ. 1978. *The Agricultural Marketing System*. Grid Publ., Ohio.
7. S Acharya & N.L. Agrawal. *Agriculture Marketing in India*, Oxford and IBH Publication
8. Shepherd SG & Gene AF. 1982. *Marketing Farm Products*. Iowa State Univ. Press.
9. Singhal AK. 1986. *Agricultural Marketing in India*. Annual Publ., New Delhi
10. Uhl & Kohl : *Agricultural Marketing*
11. Adcock D, Bradfield R, Halborg A & Ross C. 1995. *Marketing Principles and Practice*. Pitman Publ.
12. Chaston I. 1983. *Marketing in Fisheries and Aquaculture*. Fishing News Books.
13. Phillip K & Armstrong G. 2007. *Principles of Marketing*. Prentice Hall.
14. Phillip K. 2008. *Marketing Management*. 12th Ed. Prentice Hall of India.

FEC 504 ECONOMICS OF DEVELOPMENT AND PLANNING**(3+0)****Objectives**

- To provide orientation to the concepts and measures of economic development and planning.

Theory:

UNIT I

Development Economics – Scope and Importance - Economic development and economic growth, divergence in concept and approach - theories of development; Indicators and Measurement of Economic Development – GNP as a measure of economic growth – New Measures of Welfare – PQLI – HDI – Green GNP - Criteria for under development – Obstacles to economic development, Economic and Non-Economic factors of economic growth.

UNIT II

Role of fisheries in economic development, characteristics of developing and developed economies; theories of development; role of economic, technological, social, cultural, political and environmental factors; interdependence between fisheries and industrial development.

UNIT III

Growth models - Harrod-Domar, neo-classical, Von Neumann; development strategies in India; five-year plans and fisheries. Growth analysis, determinants of growth and their measurements.

UNIT IV

Planning models, features of planning in capitalist, socialist, neosocialist and mixed economies; types of planning - micro level, regional, sectoral, agroecoregional development; role of non-government organizations (NGOs) and self-help groups (SHGs) in agriculture and fisheries development; characterizing fisheries growth, changes in fishing and cropping pattern, decomposition analysis and sources of output growth; analysis of instability; capital formation, crop insurance, infrastructure; transfer of technology - constraints to technology adoption, yield gap analysis and research planning; fisheries information system. Fisheries policy analysis and reforms - energy, water, fertilizer, land, seed, labour, technology, rural infrastructure, marketing, pricing, trade etc.

UNIT V

Concepts of food and nutritional security, production oriented policies, food price policies, food subsidies, food safety and food quality. Measurement of poverty, poverty alleviation programmes.

Suggested Readings:

1. Chakaravathi RM. 1986. *Under Development and Choices in Agriculture*. Heritage Publ., New Delhi.
2. Dewett K K. 2002. *Modern Economic Theory*. S. Chand & Co.
3. M.L. Jhingam Economics of Development and Planning
4. Dutta and Sundaram Indian economy
5. H .L.Ahuja Indian Economy

FEC-505 INTRODUCTION TO ECONOMETRICS**(1+1)****Objective:**

- To familiarize students with the fundamental principles of econometrics.
- To impart knowledge of quantitative techniques for analysis of economic problems.

Theory:**UNIT I**

Definition and scope of econometrics, relationship among economic variables, mathematical economics and econometric models

UNIT II

Simple regression – assumptions, estimation and interpretation, approaches to estimation - OLS, MLE and their properties, use of instrumental variables, violation of assumptions-identification, consequences and remedies for Multi-collinearity, heteroscedasticity, autocorrelation – data problems and remedial approaches - model misspecification

UNIT III

Econometric model specification criteria, specification errors, measurement errors of dependent and explanatory variables, Different model specification criteria

UNIT IV

Introduction to time series analysis – trend, cycle and seasonality, time series models, Basic ideas in fitting non-linear regression models.

Practicals:

Exercises on fitting linear regression models, growth estimation, Use of Dummy variables. Models for qualitative dependent variable - LPM, multinomial logit models, detection of multicollinearity, heteroscedasticity and autocorrelation, Model selection; Hands on using econometric packages like SPSS and SAS.

Suggested Readings:

1. Gujarati DN. 2003. *Basic Econometrics*. McGraw Hill.
2. Koutsoyiannis A. 2007. *Theory of Econometrics*. Barner & Noble.
3. Maddala G.S. 2009. *Introduction to Econometrics*. Willey Series, 4th edition.
4. Johnson, J. and Dunando, J. 2007. *Econometric Methods* 4th edition, McGraw Hill.

FEC 506 FISHERIES FINANCE AND PROJECT MANAGEMENT**(2+1)****Objectives:**

- To highlight the different institutions catering to the fisheries financing
- To review the performance of the different fisheries financing institutions

Theory:

UNIT I

Importance of fisheries finance; principles of fisheries financial management, rural credit structure-demand and supply, sources and forms; estimation of credit requirement; cost of credit/capital; credit appraisal- 3 Rs and 3 Cs of credit;

UNIT II

Reforms in fisheries credit policy; innovations in fisheries financing – micro Finance, Kisan credit cards; role of institutions in fisheries, finance, public and private sector banks; cooperatives, micro-finance institutions(MFIs), SHGs; International Financial Institutions; successes and failures of co-operative sector in India; Role of co-operatives under emerging economic scenario.

UNIT III

Fundamentals of accounting and book-keeping; objectives and functions of financial management; analysis of financial statements- balance sheet, income statement, cash flow statement; capital structure theories; sources of long term finance and cost of capital; concepts of components of working capital, managing working capital - cash management, dividend decision; capital budgeting, appraisal criteria; fish business financing system in India-money and capital markets, national, regional and global financial institutions; insurance; risk management; micro-credit.

UNIT IV

Elements of project cycle: Identification, preparation, appraisal, financing and implementation of projects. Project Appraisal techniques : Undiscounted measures, ranking by inspection, pay-back period, average annual proceeds per unit of outlay, Time value of money – Use of discounted measures, derivation of incremental net benefit; B-C ratio, NPV and IRR. Project management Net-work Techniques – PERT and CPM.

Practicals:

Rural Lending Programmes of Commercial Banks, Lead Bank Scheme-Preparation of District Credit Plan, Preparation of financial statements using farm/firm level data, Farm credit appraisal techniques and farm financial analysis through financial statements, Different case studies on fisheries cooperative societies and their performance (marine and inland sector). Practical and Case studies: Ratio analysis, valuation of project inventories, Project appraisal techniques–undiscounted and discounted measures.

Suggested Readings:

1. FAO, 1971. Manual on Fishermen's Co-operatives, Rome.

2. Bhatia, B. S.; H. L. Verma, Mahesh. C. Harg., 2001. Encyclopaedia of Co-operative Management (Vol. I, II, III, IV), Deep and Deep publications, New Delhi
3. Rajagopalan, R., 1997. Rediscovering cooperation Vol. I, II, III, IRMA Anand.
4. Ronald W. Cotterill, 1998. Competitive Strategy Analysis for Agri-marketing Co-operatives.
5. FISHCOPFED. 1989. *Fish Co-operatives*, New Delhi.
6. Proctor T. 2005. *Essentials of Marketing Research*. Financial Times, Prentice Hall.
7. FAO Technical Paper No.334, *Fisheries Project Formulation*, FAO, Rome.
8. Shang, Y.C., *Aquaculture Economic Analysis – An Introduction*, The World of Aquaculture Society Ltd.
9. Twiner and Simister (ed.), *Project Management*, Infinity Books, New Delhi.
10. Chodhury, Project Management Tata McGraw Hill Publishing Company Ltd., New Delhi
11. Gittinger, J. Price, Economic analysis of Agricultural projects, EDI Series in Economic Development, John Hopkins University Press, Baltimore and London

FEC- 507

PRINCIPLES OF ECONOMICS

(2+1)

Objective

- To familiarize students with basic concepts of economics related to fisheries.
- To gain awareness about latest global developments which have a bearing on trade, food products safety, quality and IPR's.

Theory:

UNIT I

Basic concepts in economics; micro versus macro-economics; positive and normative economics; scarcity and choice; utility concept; production possibilities frontier; opportunity cost concept. Theory of demand and supply; laws of demand and supply; concept of elasticity and its estimation.

UNIT II

Theory of production and costs; total, average and marginal products and costs; laws of returns; returns to scale, Law of variable proportion, Profit maximization.

UNIT III

National income; concept of national income (GDP and GNP); estimation of national income. Concept of inflation, Monetary and fiscal policy

UNIT IV

Marketing- concepts and scope, Classification of markets, Market structure, conduct and performance, Marketing in a developing economy, Market functions and its importance. Marketable & Marketed surplus. Market intermediaries, price stabilization measures and

policies; channels in marketing, price spread and efficiency; market integration; Problems in marketing, co-operative marketing etc. Direct-marketing , Contract farming, Supply Chain and value chain Management.

UNIT V

Global issues in business – WTO; tariffs & non-tariff barriers; international product quality / safety standards, intellectual property issues.

UNIT VI

Application of quantitative techniques in economics and management, concept of cost-benefit analysis; break-even analysis, network techniques for managing projects, optimization and allocation techniques; decision analysis.

Practicals:

Estimation of demand and supply elasticities; Total, average and marginal costs computation; Revenue concepts; National income estimation; Organisational charts; Break-even analysis; Project management -PERT/CPM and Decision trees/analysis, Identification of marketing channels, Estimation and analysis of price spread and marketing efficiency.

Suggested Readings:

1. Samuelson, P. A. and Nordhaus, W. D. 2005. *Economics*. 18th ed. Tata McGraw Hill.

FEC 508 INDIAN ECONOMY

(2+0)

Objectives:

- To acquaint students with the different facets of the Indian economy

Theory:

Unit I

Underdevelopment and the Indian economy, National income of India, changes in farming pattern, decomposition analysis and sources of output growth; analysis of instability; capital formation, infrastructure; transfer of technology - constraints to technology adoption.

Unit II

Human development in India, Human resources and economic development, Occupational structure and economic development, Planning and Economic development, Objectives and strategy of economic planning, Industrial policy and Indian planning.

Unit III

Public sector and Indian planning, Disinvestment of public enterprises, Private sector , joint sector and Indian planning ,privatization and economic reform.

Unit IV

Food security in India, Foreign trade of India, India's balance of payment, Indian currency system, Indian financial system, problems of capital formation, Indian public finance, Government subsidies in India.

Suggested Readings:

1. Dutt R & Sundaram KPM. 2010. *Indian Economy*. S. Chand & Co.
2. Gittenger P. *Economic Analysis of Agricultural Projects*. Johns Hopkins University Press.
3. Hopkins University Press. Mozoomdar A. 2009. *The Indian Economy: A Different View*. Har-Anand Publ.
4. Vaidyanathan A. 1995. *The Indian Economy: Crisis, Response, and Prospects*. Orient Blackswan.

FEC 509

INTERNATIONAL ECONOMICS AND TRADE I

(1+1)

Objective:

- To familiarize students with basic concepts and principles of economics applied to international trade.

Theory:

UNIT I

International Economics - concepts and scope, Nature of international trade, difference between domestic and foreign trade; Theories of international trade- absolute and comparative advantage, modern theories of international trade – Heckscher Ohlin theorem.

UNIT II

Concepts of terms of trade, free trade, protection, tariffs, quantitative restrictions and other non-tariff measures; exchange rate; devaluation and depreciation; Balance of payments.

UNIT III

EXIM policy of India in relation to fish and fishery products, Export- Import procedures, and certification, Role of ECGC & EIC.

UNIT IV

Growth of marine product exports – MPEDA and its development programmes, WTO Agreement on Agriculture - Contradictions of free trade - proponents and opponents policies in vulnerable sectors like fisheries – Lessons for developing countries WTO in dispute settlement.

Practicals:

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; Case studies

on exports of value added seafood products; Case study of a seafood export firm; Case studies on use of SPS / TBT measure; Case studies on non-tariff barriers in fisheries trade; Case studies on dumping and anti-dumping measures in seafood trade; SWOT analysis of WTO; Case Studies on disputes in TRIPS.

Suggested Readings:

1. Samuelson and Nordhaus, *Economics*, Tata McGraw, Hill, New Delhi
2. Dennis Appleyard, *Trade Theory and Practice*. Irwin Publishers
3. Mithani. J.P *International Economics* Tata McGraw, Hill, New Delhi
4. Cherunilam Francis *International Economics* Tata McGraw, Hill, New Delhi
5. Apple yard DR & Field A. J. 2001. *International Economics*. 4th Ed. McGraw Hill.
6. Francis C. 2008. *International Economics*. Tata McGraw Hill.
7. Krugman PR & Obstfeld M. 1991. *International Economics: Theory and Policy*. Harper Collins Publ.

FEC 510

ENVIRONMENTAL ECONOMICS I

(1+1)

Objectives:

- To introduce economics principles releavent to natural resource and environmental economics
- To understand the environmental policy issues and alternative instruments of environmental policies

Theory:

UNIT I

Ecology and economics - principles of environmental economics – public goods, club goods and theory of common property - property rights and ownership incentives equimarginal principle, discounting and risk, user cost, existence value - substitution between capital and natural resources - environmental externalities. Population question and theory of demographic transition - poverty, development and environment – environment and trade - concept and practice of sustainability.

UNIT II

Concept of sustainable development - Economic Perspective - Indicators of sustainability Relation between development and environment stress- Environmental Kuznet's curve Environmental Accounting – resource accounting methods - International Environmental Issues – climate change – likely impacts -mitigation efforts and international treaties.

UNIT III

Concepts of market and non-market valuation of natural resources /environment. Taxonomy of valuation- techniques- market based / incentive based strategies like emission taxes and subsidies, transferable discharge permits - polluter pays principle. Productivity change method – substitute cost method - Hedonic price method - Travel cost method –Contingent valuation methods. Discount rate in natural resource management,

UNIT IV

Kyoto Protocol, carbon trading, CDM and GEF – environmental policies in major industrialized and industrializing countries – international environmental agreements.

UNIT V

Concept and principles of EIA; methodologies for EIA in fisheries and aquaculture sector; Institutional (International/National/State/Local) arrangements and strategies for estimation, amelioration and compensation for impacts; Aquaculture Authority Bill and AAI. Environment related conflicts and dispute resolution; Coasian theorem and stakeholder decision making process.

Practicals:

Case studies on environmental economics of shrimp farming (intensive/semi-intensive/ extensive) and poly culture farms - Application of Extended Domestic Resource Cost Ratio and Policy Analysis Matrix for aquaculture-Case studies on the sustainability of various capture fishery systems -Economics of inland water and marine pollution - economics of pollution control - economics of climate change, global warming and fisheries development - Gordon-Schaefer growth model, Dynamic Poll model and Bio-economic model of fisheries resource management.

Exercise on pollution abatement, Concepts in valuing the environment, Taxonomy of valuation techniques, Productivity change method, substitute cost method, Hedonic price method, Travel cost method, Contingent valuation methods, Discount rate in natural resource management, Environmental impact assessment, Visit to Pollution Control Board.

Suggested Readings:

1. Ahmad Y, El Serafy S & Lutz E. (Eds.). 1989. Environmental Accounting for Sustainable Development. World Bank.
2. Freeman AM. 1993. *The Measurement of Environmental and Resource Values*. Resources for the Future Press, Baltimore.
3. Hackett SC. 2001. *Environmental and Natural Resource Economics: Theory, Policy, and the Sustainable Society*. M. E. Sharpe, Armonk, NY.

4. Hartwick JM & Olewiler ND. 1998. *The Economics of Natural Resource Use*. 2nd Ed. Addison-Wesley Educational Publ.
5. Kerr JM, Marothia DK, Katar Singh, Ramasamy C & Bentley WR. 1997. *Natural Resource Economics: Theory and Applications in India*. Oxford & IBH.
6. Kolstad CD. 2000. *Environmental Economics*. Oxford Univ. Press.
7. Pearce DW & Turner K. 1990. *Economics of Natural Resources and the Environment*. John Hopkins Univ. Press.
8. Prato T. 1998. *Natural Resource and Environmental Economics*. Iowa State Univ. Press.
9. Sankar U. 2001. *Environmental Economics*. Oxford Univ. Press.
10. Sengupta R. 2000. *Ecology and Economy, an Indian Perspective*. Oxford Univ. Press.
11. Tietenberg T. 2003. *Environmental and Natural Resource Economics*. 6th Ed. Addison Wesley.
12. Bartlett, C. and Piramal, G., *World class in India: A case book of companies in transformation*, Penguin India.
13. Krueger, N.F., *Entrepreneurship—Critical Perspectives on Business Management*
14. Livessay, H.C., *Entrepreneurship and Growth of Firms*, Vol I & II.
15. FICCI, *A Pectoral History of Indian Business*, OUP.

FEC 511 MATHEMATICS FOR FISHERIES ECONOMICS

(1+1)

Objective:

- To familiarize the student with basic concepts matrix and vectors
- To understand the concept and principles of differentiation and integration of functions and their applications

UNIT I

Matrix Algebra- Basic terminology, linear independence and dependence of vectors. Row and column spaces, Echelon form. Determinants, rank and inverse of matrices, System of linear equations, Special matrices – idempotent, symmetric, orthogonal. Eigen-values and Eigen-vectors.

UNIT II

Calculus: Limit and continuity, differentiation of functions, successive differentiation, partial differentiation, mean value theorems, Taylor and Maclaurin's series.

UNIT III

Application of derivatives, L'hospital's rule. Integration of rational, irrational and trigonometric functions. Application of integration.

UNIT IV

Differential equation: Differential equations of first order, linear differential equations of higher order with constant coefficient. Numerical Analysis: Simple interpolation, divided differences, Numerical differentiation and integration.

Practical:

Matrix Algebra, Application of differentiation & integration in fisheries economics, Application of differential equations & numerical analysis in fisheries economics.

Suggested Readings:

1. Martin Anthony, Mathematics for Economics and Finance, Cambridge University Press
2. Dean Corbae, Maxwell B. Stinchcombe, Juraj Zeman, An Introduction to Mathematical Analysis for Economic Theory and Econometrics, Princeton University Press
3. Carl P. Simon, Lawrence E. Blume, Mathematics for Economists
4. Schaum's, Mathematical Methods for Business and Economics, Amazon Publication

FEC 512

AQUACULTURE PRODUCTION ECONOMICS

(1+1)

Objective:

- To expose students the concept, significance and uses of aquaculture production economics.

Theory:

UNIT I

Nature, scope and significance of aquaculture production economics- Aquaculture Production processes, character and dimensions-spatial, temporal - Centrality of production functions, assumptions of production functions, commonly used forms- Properties, limitations, specification, estimation and interpretation of commonly used production functions.

UNIT II

Factors of production, classification, interdependence, and factor substitution - Determination of optimal levels of production and factor application –Optimal factor combination and least cost combination of production - Theory of product choice; selection of optimal product combination.

UNIT III

Cost functions and cost curves, components, and cost minimization –Duality theory – cost and production functions and its applications -Derivation of firm's input demand and output supply functions -Economies and diseconomies of scale.

UNIT IV

Technology in agricultural production, nature, effects and measurement -Measuring efficiency in agricultural production; technical, allocative and economic efficiencies - Yield gap analysis-concepts-types and measurement, Nature and sources of risk, modeling and coping strategies.

Practicals:

Different forms of production functions - specification, estimation and interpretation of production functions – returns to scale, factor shares, elasticity of production - physical optima-economic optima-least cost combination- optimal product choice- cost function estimation, interpretation-estimation of yield gap -incorporation of technology in production functions- measuring returns to scale risk analysis through linear programming.

Suggested Readings:

1. Beattie BR & Taylor CR. 1985. *The Economics of Production*. John Wiley & Sons.
2. Doll JP & Frank O. 1978. *Production Economics - Theory and Applications*. John Wiley & Sons.
3. Gardner BL & Rauser GC. 2001. *Handbook of Agricultural Economics*. Vol. I.
4. *Agricultural Production*. Elsevier.
5. Heady EO. *Economics of Agricultural Production and Resource Use*. Prentice-Hall.
6. Sankayan PL. 1983. *Introduction to Farm Management*. Tata Mc Graw Hill.

FEC 513

GIS AND REMOTE SENSING

(1+1)

Objective:

- To familiarize the students with basic concepts and practice of GIS and Remote Sensing

Theory:

Unit I

Fundamentals concepts: What is GIS? GIS data formats, GIS Subsystems, Components of GIS, GIS data models, Spatial Data and attribute data, Different types of spatial data, Vector, Raster and Image, Advantages and disadvantages of vector and raster models, Spatial data relationships, Attribute data models - tabular and relational models (RDBMS),Data sources; Digital Elevation Models; Spatial modeling. Manual and automatic digitizing process; Data errors in GIS; Classification methods- multivariate tools, Spatial interpolation.

Unit II

Introduction of remote sensing, Satellites and their characteristics; Satellite Remote Sensing and Sensors; Spectral signatures of earth surface features. Remote sensing as an input to GIS, Use of GPS, Data editing and quality assurance, Map features –point, line, polygon, area, Map characteristics, map projection and co-ordinate system, Creation of thematic layers, Introduction to GIS software; Applications of Remote Sensing and GIS in Fisheries and Aquaculture(Potential Fish Zone forecasting(PFZ), Site selection of aquaculture etc.)

Practicals:

Familiarization with GIS software and use of GPS; Map scanning and geo-registration of topo-sheet, satellite image and administrative map, Introduction to image classification, Digitization of different features from topo-sheet and satellite image, Creation of attribute table, joining of tables, Creation of different thematic layers, Analysis of Interpolation and classification. PFZ forecasting and site selection for aquaculture.

Suggested Readings:

1. Floyd F. Sabins, 2007. *Remote Sensing: principles and Interpretation*, W.H. Freeman & Co, New York
2. Thomas M. Lilles and Ralph Kiefer, 2000. *Remote Sensing and Image interpretation*, John Wiley & Sons, New York
3. Michael N. DeMers, 2007. *Fundamentals of Geographic Information Systems*, John Wiley & Sons, New York
4. James B Campbell, 2011. *Introduction to Remote Sensing*, Taylor and Francis, New York
5. Peter M. Atkinjou and Nicholas J Tale (Ed.), 2000. *Advances in Remote Sensing and GIS Analysis*, John Wiley & Sons, New York
6. Course Manual of Winter School on Remote Sensing and GIS Applications in Fisheries Research and Management, 5-25 January, 2005, CIFE, Mumbai
7. P.A. Burrough and R.A. McDonnell, 1999. *Principles of Geographic Information Systems*, Oxford University Press.

SUPPORTING SUBJECTS

FST- 501

RESEARCH METHODOLOGY

(1+1)

Objectives:

- To learn basic concepts and terms in research, and understand research processes
- To develop research skills in planning, designing, conducting and writing of research

Theory:**UNIT I**

Definition and characteristics of research; types of research; research paradigms; research ethics; Research process: steps in planning and conducting a research study

UNIT II

Formulating a research problem: reviewing the literature, identifying researchable problem, defining research objectives, identifying variables, constructing hypotheses; Conceptualizing a research design: research design, selecting an appropriate research design in fisheries science research; Selecting a method of data collection, establishing validity and reliability; selecting a sampling framework

UNIT III

Writing a research proposal; Collecting data: ethical issues concerning different stakeholders; Processing data: editing and coding of data & developing a frame of analysis, writing a research report: types and formats of reports, writing Masters' thesis, writing a research article

Practicals:

Exercises on literature review – searching offline and online catalogues and journals (OPAC, ASFA, CeRA, etc); Exercises / case studies on formulation of researchable problem, research questions, research objectives; Exercises / case studies on defining variables construction of hypotheses; Exercises / case studies on selection of appropriate research design; Constructing on instrument for data collection; Exercises on preparing a research proposal / outline of research work; Exercises on critical review of research articles, theses and their presentation; Exercises / case studies on writing a research article

Suggested Readings:

1. Kothari, C. R., 2008. *Research Methodology: Methods and Techniques* (2nd Ed.), New Age International Publications, New Delhi
2. Kumar, Ranjit, 2012. *Research Methodology: A Step-by-Step Guide for Beginners* (3rd Ed.), Sage Publications, New Delhi
3. Rossiter D.G., 2003, *Preparation for M.Sc. Thesis Research*, IT, Netherlands
4. <http://www.socialresearchmethods.net/>

FST 502 STATISTICAL METHODS**(1+2)****Objectives:**

- To acquaint students with various statistical methods and techniques

- To provide hands-on-training in data analysis both using step-by-step approach and also through statistical software

Theory:

UNIT I

Levels of measurement, Descriptive statistics; Theory of probability, Random variable; Probability distributions, mathematical expectation; Binomial, Poisson and Normal distributions and their applications in fisheries

UNIT II

Concept of sampling distribution, standard error, confidence interval, test of hypotheses, type I and type II errors, level of significance; χ^2 , t and F distributions; Tests of significance based on Z, χ^2 , t and F distributions.

UNIT III

Simple correlation, rank correlation; Simple and multiple regression models; Length-weight relationship in fisheries; Index numbers

UNIT IV

Planning of an experiment and basic principles of design of experiments (Randomization, Replication and Local control); Analysis Of VAriance (ANOVA), Completely Randomized Design (CRD), Randomized Complete Block Design (RCBD), Latin Square Design (LSD); Introduction to factorial experiments

UNIT V

Planning of sample surveys; Sampling versus complete enumeration; Sampling designs: Simple random sampling, Stratified sampling, Systematic sampling, Cluster sampling, Multistage sampling and their applications in fisheries; sample size determination, Estimation of marine and inland fish landings in India and problems encountered

UNIT VI

Non-parametric tests, advantages and limitations over parametric tests; Run test, Sign test, Wilcoxon-Mann-Whitney U test, Kolmogorov-Smirnov test, Kruskal-Wallis test and Friedman's test; Shapiro-Wilk test

Practicals:

Descriptive statistics; Exercises on Probability distributions; Testing of hypothesis based on normal, χ^2 , t and F distributions; Correlation and regression analyses; Analysis of data obtained from CRD, RBD, LSD; Exercises on selection of samples and estimation of population means using sampling designs; Exercises on non-parametric tests

Suggested Readings:

1. Biradar, R.S. (2002). *Course manual on Fisheries Statistics*, 2nd Edition, CIFE, Mumbai
2. Das, M. N. and Giri, N.C. (1986). *Design and Analysis of Experiments*. New Age, Delhi

3. Gupta, S.C. and Kapoor, V.K. (2007). *Fundamentals of Mathematical Statistics*. Sultan Chand and Sons, New Delhi.
4. Siegel, S. and Castellan Jr., N.J. (1988). *Non-parametric statistics for the behavioural sciences*, McGraw Hill Company Limited, New York.
5. Sukhatme, P.V., Sukhatme, B.V., Sukhatme, S. and Asok, C. (1984). *Sampling theory of surveys with applications*, 3rd edition, ISAS, New Delhi.