



MADRAS SCHOOL OF ECONOMICS

(Institution of Special Importance)

Gandhi Mandapam Road, Chennai – 600025.

MA Actuarial Economics

Two-Year, Four-Semester Programme (Indian PG Credit System)
Aligned with Institute and Faculty of Actuaries (IFoA) Syllabi and
the University of Kent (UK) Framework

Syllabus revised in accordance with the recommendations of the Advisory Board of external academicians and industry experts, MSE Executive Council and Academic Council.

*Course Descriptions and IFoA Alignment for
New and Revised Courses*

Academic Year 2026–2027 onwards

COURSE LIST (AY: 2026 - 27 ONWARDS)

SEMESTER	COURSE CODE	COURSE TITLE	TYPE	COMUPULSORY/ OPTIONAL
Semester 1	AE03	Mathematical Statistics	core	COMUPULSORY
	AE01	Microeconomics 1	core	COMUPULSORY
	AE02	Macroeconomics 1	core	COMUPULSORY
	AE04	Mathematics for Actuaries	core	COMUPULSORY
Semester 2	AE18	Life Contingencies - I	core	COMUPULSORY
	AE19	Probability and Risk Modelling	core	COMUPULSORY
	AE07	Financial Economics	core	COMUPULSORY
	AE08	Econometric Methods	core	COMUPULSORY
	AE11	Economics of Insurance	core	COMUPULSORY
Summer internship				COMUPULSORY
Semester 3	AE20	Life Contingencies - II	core	COMUPULSORY
	AE38	General Insurance Modelling	core	COMUPULSORY
	AE21	Stochastic Risk Modelling	core elective	COMUPULSORY
	AE23	Risk analysis and Management*	elective	OPTIONAL
	AE10	Applied Microeconometrics*	elective	OPTIONAL
Semester 4	AE15	Survival Models	core	COMUPULSORY
	AE39	Regulation and Insurance Markets	core	COMUPULSORY
	AE12	Finance and Financial Reporting	core elective	COMUPULSORY
	AE29	International Trade*	elective	OPTIONAL
	AE35	International Finance*	elective	OPTIONAL
	AEPR	Dissertation (no choice of elective)		OPTIONAL
*electives are subject to change based on the list of courses offered each year				

DETAILED SYLLABUS OF THE CORE AND ELECTIVE COURSES

AE 01: MICROECONOMICS

Course Type: Core

IFoA Alignment: CB1

Module structure

1: Consumer Behaviour and Demand

Consumer preferences, Opportunity sets, optimum choices, indirect utility demand functions, income and substitution effects, Slutsky equation, normal versus inferior goods, types of demand functions, elasticity, welfare evaluation, consumer surplus, equivalent variation and compensating variation, revealed preference (weak and strong axioms)

2: Utility Functions and Expected Utility Theorem

Expected utility function, measures of risk aversion, state-preference approach, portfolio theory and pricing of risk, present discounted value approach to investment decisions, adjustments for risk

3: Production and Cost

Production functions, types of production functions (Cobb-Douglas, CES, etc.), marginal products, rate of technical substitution, technical progress, cost functions, average and marginal costs, short run versus long run costs, economies of scale and scope, profit maximization, cost minimization, derivation of input demand

4: Competitive Markets

Assumptions of perfect market, competitive markets – demand and supply, demand and supply curves of individual firms, short-run versus long-run, competitive market equilibrium, tax incidence analysis, price-controls and shortages.

5: Imperfect Competition

Market failure, imperfect markets, sources of monopoly power, monopoly market equilibrium, price discrimination – first, second and third degree, tax incidence, oligopoly, Cournot Model, Stackelberg model, Bertrand Model, Monopolistic Competition.

Reference Books

- Varian, H. R., Microeconomic Analysis, third edition, W.W. Norton and Co., 1992
- Mas-collel, Whinston and Green (1995): Micro-economic Theory, OUP
- Gravelle, H and R. Rees: Microeconomics, Pearson Education, 3rd Edition, 2004
- Henderson, M. and R.E. Quandt, Microeconomic Theory: Mathematical Approach, McGraw Hill, 3rd edition.
- Koutsoyiannis. A. “Modern Microeconomics” (Macmillan Press Limited, New York)

Review Books

- Varian, H. R., Intermediate Microeconomics: A Modern Approach, third edition, 2010.
- Nicholson, W., Microeconomic Theory: Basic Principles and Extensions, eighth edition, South Western Thomson Learning, 2002

AE02: MACROECONOMICS

Course Type: Core

IFoA Alignment: CB1

Module structure:

1. National Income Accounting

Accounting structure, key concepts in accounting for both closed and open economies – gross national product, gross domestic product, net national product, national income, savings and investment, balance of payments, circular flow of income, computational problems – expenditure approach, income approach and value added approach for measurement, input-output tables

2. Keynesian Models

Simple Keynesian Model, assumptions, concepts of involuntary unemployment, liquidity preference, paradox of thrift, investment function, IS-LM model – two sector model, goods and money market equilibrium, multiplier, liquidity trap, complete Keynesian model – three sector model, role of government in terms of monetary and fiscal policy

3. Keynesian Models versus Classical Models

Says Law, quantity theory of money, price flexibility and full employment, Clowers and Patinkin's money demand functions, equilibrium concept in classical model, synthesis between classical models and Keynesian models, interpretation and policy analysis

4. Expectations and Macroeconomic Adjustments

Expectations formations – Adaptive and rational expectations hypothesis, partial adjustment model, Lucas critique, Phillips curve, rules versus discretion, time consistency, inflation targeting, interest rate rules, effects of spending and taxes in models with flexible and sticky prices, perverse effects of fiscal expansion

5. Macroeconomics: Open Economy Aspects

Market for foreign exchange, devaluation and depreciation, real and nominal exchange rate, factors affecting exchange rate, Mundell-Fleming model, fixed versus floating exchange rate, price adjustment, role of fiscal and monetary policies under alternative exchange rate regimes, purchasing power parity concept

Reference Books

- Scarth, W., Macroeconomics: An Introduction to Advanced Methods, third edition Thomson, 2007
- Mankiw, N. G., Macroeconomics, fifth edition, Worth Publishers, 2002
- Hall, E. and Taylor, J. B. Macroeconomics. W. W. Norton and Company, 1986
- Barro, R.J. Macroeconomics, Fifth edition, MIT Press 1997

AE: 03 MATHEMATICAL STATISTICS

Course Type: Core

IFoA Alignment: CS1

Module structure:

1. Probability Theory
Concept of probability, conditional probability and Bayes' theorem; Random variables –discrete and continuous, Density and distribution functions, joint, marginal and conditional distribution, moment generating function.
2. Probability Distributions
Discrete versus continuous distribution, uniform, binomial, negative binomial, Poisson, geometric and hyper-geometric, exponential, normal, log-normal and gamma; joint, marginal and conditional distribution, functions of random variables.
3. Sampling Methods and Sampling distributions
Simple random sampling: with and without replacement, stratified random sampling, probability and non-probability sampling, statistic and sample moments, sampling distributions: Student's *t*, Chi-square and F-distribution, determinants of sample size, law of large numbers and Central Limit theorem.
4. Estimation
Point estimation of population mean for large sample and small sample, estimation of population proportion and population variance, Maximum likelihood and method of moment estimation, properties of good estimators: unbiasedness, consistency, efficiency, sufficiency, Rao-Blackwell Theorem, Cramer-Rao Identity, Interval estimation.
5. Hypothesis Testing
Statistical hypothesis, simple versus composite hypothesis, critical region, types and size of error – type-I and type-II error, power of a test, p-value, Hypothesis test about: a population mean, population proportions, difference between two population means, difference between two proportions, a population variance, the ratio of two population variances.

Reference Books

- DeGroot, M.H. and M.J. Schervish, Probability and Statistics,
- Hogg, R. and A. Craig, J., Introduction to Mathematical Statistics, McGraw-Hill, 1965.
- Miller, I. and M. Miller, Mathematical Statistics, sixth edition, Prentice Hall International, 1999.
- Mood, A. M., R. A. Graybill and R.C. Boes, Introduction to the Theory of Statistics, McGraw-Hill, 1974.
- Ramachandran, K. M and C. P. Tsokos, Mathematical Statistics with Applications, 2009.

AE 05: MICROECONOMICS II

Module structure:

1. General Equilibrium and Welfare Economics

Absolute versus relative prices, perfectly competitive price and general equilibrium models – with and without production, uniqueness and determinacy, Edgeworth box, Pareto improvement and efficiency, Walrasian equilibrium, money in general equilibrium

2. Welfare Economics

Arrow-Debreu economy, welfare theorems, existence of Walrasian equilibrium, fixed-point theorem, core and core convergence, general equilibrium with time and uncertainty, Jensen's Inequality, social welfare function, transfer efficiency; Kaldor-Hicks-Samuelson criterion, Rawl's theory of social justice

3. Market Failure and Public Goods

Reasons for market failure – market imperfections, public goods, externality, macro-economic factors; types of public goods, theory of public goods – provision and pricing, government intervention, second-best solution, free riding, types of externalities – production and consumption externalities, Pigovian and Coasian solutions

4. Asymmetric Information

Moral hazard problem, adverse selection, principal agent problem, theory of lemon, credit market, implications of asymmetric information, market signaling, hidden information modeling, efficiency wage model, information and insurance

5. Game Theory

Sequential and simultaneous games, extensive forms and normal forms, dominant strategies and elimination of dominated strategies, Nash equilibrium, Dynamic games, backward induction, sub- game perfect equilibrium, applications with oligopoly markets: Cournot, Bertrand, Stackleberg and cartel

Reference Books

- Varian, H.: Microeconomic Analysis, W.W. Norton, 3rd Edition, 1992
- Henderson, M. and R.E. Quandt, Microeconomic Theory: Mathematical Approach, McGraw Hill, 3rd edition.
- Gravelle, H and R. Rees: Microeconomics, Pearson Education, 3rd Edition, 2004.
- Mas-Colell, A., M. Whinston and J Green: Microeconomic Theory, Oxford University Press, 1995
- Gibbons (1992): Game Theory for Applied Economists, Princeton University Press
- Mukherji, A.: Walrasian and Non-Walrasian Equilibria: An Introduction to General Equilibrium Analysis, Clarendon Press, Oxford, 1990.
- Recent research papers in Microeconomics will be discussed

AE 06: FINANCIAL MATHEMATICS

Module structure:

1. Basic Financial Calculations

Introduction: financial securities- zero coupon bond, fixed interest, index linked securities etc.; the time value of money; nominal Vs. real interest, deflationary conditions; accumulating factors, force of interest, compound interest functions.

2. Annuities and Equation of Value

Discounting and Accumulation: discrete and continuous cash flows; level annuities, deferred and increasing/decreasing annuities, equation of value and yield on transaction, probability of cash flows, higher discount, loan schedules; consumer credit: flat rate and APRs.

3. Capital Budgeting Techniques and Compound Interest Problems

Introduction to financial statement, assessing financial performance, net present value, internal rate of return, payback period; projects with different lives; money and time weighed rate of return; fixed interest securities, uncertain income securities, equities, valuing a loan with allowance for capital gains and indexation.

4. Arbitrage, Forward Contracts, and Term Structure of Interest

Rationale for no arbitrage assumption; forward contracts, calculating the forward price for a security with known dividend yield; hedging, fixed cash income; Discrete time and continuous time rates; continuous time spot rates and forward rates; instantaneous forward rates; theories of time; term structure of interest rates; yield curve; yields to maturity; convexity and immunization; interest rate risk.

5. Stochastic Interest Models and Investments

Simple stochastic interest rate models, fixed and varying interest model, log normal distribution; fixed interest government borrowings, government bonds, tax, security, marketability and return; government bills: corporate debt, debentures, unsecured loan stocks, eurobonds, certificates of deposit, convertibles, property, derivatives, future, range of futures, clearing house, margin, bond futures, short interest futures, stock index futures etc.,

Reference Books

- Ross, S.M., An Introduction to Mathematical Finance, Cambridge University Press, Norton, London, 1999
- Watsham, T.J. and Perramore, K., Quantitative Methods in Finance, International Thomson Business Press, 1997
- Karatzas, L. and S.E. Shreve, Methods of Mathematical Finance, Springer, 1998
- Martin, P.G. and B.Michael, Applied Financial Mathematics, Prentice Hall, 1991
- Baxter, M. and A. L. Rennie, Financial Calculus, Cambridge University Press, 1996

AE 07: FINANCIAL ECONOMICS

Course Type: Core

IFoA Alignment: CB1

Module structure:

1. Introduction to Financial Markets

Capital markets, consumption and investments with and without capital markets, market places and transaction costs and the breakdown of separation; Fisher separation theorem; the agency problem; maximization of shareholder's wealth, capital budgeting techniques

2. Choice under Uncertainty

Axioms of choice under uncertainty; utility functions; expected utility theorem; certainty equivalence, measures of risk-absolute and relative risk aversions; stochastic dominance-first order, second order and third order; measures of investment risk-variance of return, semivariance of return, shortfall probabilities

3. Mean-Variance Portfolio Theory

Measuring portfolio return and risks, effect of diversification, minimum variance portfolio, perfectly correlated assets, minimum variance opportunity set, static portfolio choice; mean-variance frontier of risky and risk-free asset.

4. Introduction to Asset Pricing

Capital asset pricing model; empirical methods to test models of asset pricing; Factor models and cross section of stock returns; arbitrage pricing theory and models

5. Efficient Market Hypothesis

Defining capital market efficiency, relationship between the value of information and efficient capital markets, rational expectations and market efficiency, market efficiency with costly information, efficient capital market theory and empirical models

Reference Books

- Copeland, T. E. and J. F. Weston, Financial Theory and Corporate Policy, Addison Wesley, 1992
- Elton, E.J and M.J. Gruber, Modern Portfolio Theory & Investment Analysis, (fourth edition) John Wiley & Sons 1991.
- Houthakker, H.S. and P.J. Williamson, Economics of Financial Markets, Oxford University Press, 1996
- John Y. Campbell and Luis M. Viceira, Strategic Asset Allocation: Portfolio Choice for Long-Term Investors, Oxford University Press, 2002
- Christian Gollier, The Economics of Risk and Time, MIT Press, 2001

AE 08: ECONOMETRIC METHODS

Course Type: Core

IFoA Alignment: CS1

Module structure:

1. Simple Regression Analysis

Specification of the two variable regression model, Ordinary Least Squares estimation, Assumptions, BLUE property, General and confidence approach to hypothesis testing, partial effects and elasticity, goodness of fit, model evaluation, ANOVA

2. Multiple Regression Analysis

Motivation, Assumptions and OLS estimation, Interpretation of OLS estimation, Goodness of fit, matrix approach to linear regression models, testing of hypothesis for a single parameter, for linear combination of parameters, for multiple linear restrictions. Choice of function forms: linear, log-linear, log-log, quadratic functional forms, Box-Cox test, models with quadratics and interaction terms.

3. Dummy Variables

Regression on dummy (qualitative) variables with two categories, with more than two categories- intercept shifters, dummy variable trap, interaction of two categorical variables, interaction of categorical and continuous (quantitative) variables- slope shifters, piecewise linear regression model, Chow test for cross-section data and for time-series data (test structural stability of regression models)

4. Extensions of Linear Models and Non-Linear Estimation

Method of maximum likelihood and its properties (including consistency), trinity of classical tests (Wald test, Lagrange multiplier, likelihood ratio), Consequences, detection and remedial measures of multicollinearity, heteroskedasticity (WLS, MLE), and autocorrelation (GLS), Specification error (omitted variable, inclusion of irrelevant variables, measurement error in dependent and independent variables), method of moments (IV method)

5. Multi-Equation Models

Seemingly unrelated regression and its application, Structural equation models-specification, endogenous, exogenous and predetermined variables, structural versus reduced form, simultaneity bias, identification: rank versus order condition, exact and over identifications, methods of estimation: indirect least squares, instrumental variable estimation, two-stage least squares and three-stage least squares.

Reference Books

- Gujarati and Porter, Basic Econometrics, Fifth Edition, McGraw Hill/Irwin, 2009.
- Greene, William H. Econometric Analysis. 6th Edition, Prentice Hall. 2008.
- Johnston J. and DiNardo, J. Econometric Methods. 4th Ed. McGraw-Hill 1997. Greene

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- Ramanathan, Ramu, *Introductory Econometrics with Applications*, 5th edition, 2002, Thomson Asia Pte Ltd., Singapore.
- Stock, James H., and Mark W. Watson (2006): *Introduction to Econometrics*, Second Edition, (Addison-Wesley Series in Economics).
- Wooldridge, J., *Introductory Econometrics: A Modern Approach*, 2015, Nelson Education.

AE 09: INDIAN ECONOMIC DEVELOPMENT

Module structure:

1. Development Phases and Indian Economy

The Colonial Legacy - State of the economy at independence - policy of planned development – growth and structural change till the ‘eighties – evolution of controls and obstacles to fast growth – new economic policy – performance of the economy since 1991 – major aspects of transformation – recent developments.

2. Agricultural and Rural Sector

Review of agricultural growth – land reforms – agricultural research and green revolution, policy initiatives, diversification and exports – impact of liberalisation and WTO - investment in agriculture and irrigation – water policy – food security – agrarian distress-agricultural subsidies

3. Industrial Sectors

The growth and maturing of Indian industry since liberalisation – productivity growth and rise in competitiveness – exports – rise of service industry – India and I.T. – policy regarding public enterprises – disinvestment and privatisation – impact of WTO and trade liberalisation

4. Services and Infrastructure Sector

The growth and dominance of services sector in India; Sub sectors growth; regional dimension; State of infrastructure – reforms: restructuring, pricing and regulation – promoting investment in infrastructure – public – private partnership – Sectoral Issues –energy, transport, telecom, urban infrastructure

5. Social Development

Human development indicators: review of change since early fifties – wide regional variations – measurement of poverty and inequality – extent of reduction in poverty – demographic transition-health services, health policy; education policy; financing of health and education; – employment and unemployment trends; employment guarantee scheme – environmental protection – Sustainable Development Goals

Text Books

- Basu, Kaushik India's Emerging Economy: Performance and Prospects in the 1990s and Beyond, The MIT Press, 2004
- Jalan, B. (ed.), The Indian Economy: Problems and Prospects, Penguin Books, 1992
- Krueger A. (ed.), Economic Policy Reforms and the Indian Economy, Oxford University Press, 2003
- Panagariya, Arvind, India the Emerging Giant, Oxford University Press, 2008 Reference Books
- Economic Survey, Government of India, Various Issues
- India Development Report, Oxford University Press, Various Issues
- Kapila, U. (ed.), Indian Economy since Independence, Academic Foundation, Various Issues
- Nayak, Pulin, Economic Development of India (Critical Concepts in Economics), London & New York, Routledge, 2015
- Roy, Tirthankar, The Economic History of India 1857-1947, 3rd edition, Oxford University Press India, Delhi, India, 2011

AE 10: APPLIED MICROECONOMETRICS

Module structure:

1. Discrete Response Models

Introduction to binary variables, Linear probability models and their limitations, Normal and Logistic curve, Probit and Logit models, estimation and inference, hypothesis testing, odds ratios, marginal effects and goodness of fit measures, Multinomial models, Ordinal models, testing parallel regression assumption

2. Count data, Two-part and Duration Models

Count data models (Poisson, Negative binomial models), Two parts models (Sample Selection, Zero-inflation, Hurdle models), Censored versus truncated data, censored and truncated normal distributions, Truncated regression, Censored (TOBIT) regression, Duration/hazard models

3. Panel Data Models

Introduction to panel data, pooled repeated cross-section model, within and between estimators, one-way fixed effects model, fixed effects model using least squares dummy variable approach, first difference estimator, random effects model, time fixed effects, Tests of hypothesis for pooled or fixed effects model, pooled and or random effects models (Breusch-Pagan Lagrange Multiplier Test) and fixed or random effects (Hausman test), Hausman-Taylor estimator, Mundlak and Chamberlain's approach.

4. Causal Inference I

Causality, Potential outcomes approach (Counterfactual responses and the fundamental identification problem), Randomized experiments, Selection on observables: Regression approach, Matching methods (covariate matching), Propensity score (Estimation and matching)

5. Causal inference II

Difference in Difference (Identification, estimation and falsification tests), Instrumental Variables (Identification, Wald Estimator, Local Average Treatment Effect, 2SLS, Weak Instruments), Regression Discontinuity Design (Sharp Vs Fuzzy RD), Other extensions

Reference Books

- Greene, William H. *Econometric Analysis*. 6th Edition, Prentice Hall. 2008.
- Greene, William H., and David A. Hensher. *Modeling ordered choices: A primer*. Cambridge University Press, 2010.
- Angrist, J. D., & Pischke, J. S. (2008). *Mostly Harmless Econometrics: An Empiricist's Companion*. Princeton University Press.
- Baltagi, *Econometric Analysis of Panel Data*, 5th Edition, Wiley, 2013
- Cameron, C.A. and Trivedi, P.K. *Microeconometrics: Methods and Applications*. Cambridge U.P., 2005.
- Wooldridge, J. M. *Econometric Analysis of Cross Section and Panel Data*. The MIT Press, 2nd edition, 2010.

In each of the topics, examples will be discussed based on recent journal articles and working papers and the reading material will be shared with the students by the course instructor.

AE 11: ECONOMICS OF INSURANCE

Course Type: Core

IFoA Alignment: CS1

Module structure:

1. Economic Foundations

Expected utility, St. Petersburg paradox, Bernoulli's solution, Von Neumann-Morgenstern Expected utility theorem, Risk preference, Demand for full insurance, maximum premium, Insurance at Fair Odds, Partial Insurance, Insurance Market-State Space Approach, contingent commodities, zero profit constraint, odd price ratio,

2. Asymmetric Information and Insurance

Moral Hazard and Insurance, Insurance and Selection Problems, single Crossing Property; Imperfect information: pooling, contract, separate insurance, self-selection constraint, separating equilibrium,

3. Risk Management and Insurance

The concept of risk; Business risks and Individual risks; Risk management methods-loss control, loss financing and internal risk reduction methods; frequency of loss, magnitude and severity of loss; Important distributions of claim costs; diversification and pooling arrangement; contract costs; diversification of underwriting risk; reinsurance; proportional and non-proportional contracts; Insolvency issues;

4. Insurance Pricing and Selective Insurance Products

Fundamentals – fair premium; fair profit loading; Actuarial Science pricing techniques- individual risk theory and collective risk theory; financial pricing of Insurance-insurance capital asset pricing model; present value model and option pricing model; types of insurance products; life and health insurance- term, endowment and whole life policies; universal and variable life; group insurance; annuity contracts with level and varying benefits; future life time random variable, its distribution function, force of mortality, curtate future life time; deferred probabilities; analytical laws of mortality-Gompertz, Maheham, single decrement life table, select and ultimate life table.

5. Experience Rating and Credibility Theory

Experience or merit rating, risk classification, Bonus Malus System; Credibility theorem-Empirical Bayes approach to credibility theory, credibility premium formulae and standard elementary models, credibility premiums, full and partial credibility; the aggregate claim distribution for short term insurance contracts, aggregate claim distribution and application of binomial, Poisson, negative binomial distribution and normal distribution

Reference Books

- Harrington and G. Niehaus, Risk Management and Risk, Tata McGraw-Hill, second edition, 2004.

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- Black, K. and H. Skipper, Life and Health Insurance, Pearson Education, thirteenth edition, 2004
- Brian Hiller, Economics of Asymmetric Information
- Walter Nicholson, Microeconomic Theory (8th Edition)
- Hun Seog S. Economics of Risk and Insurance, Wiley-Blackwell.
- Hans U. Gerber, Life Insurance Mathematics, Springer.

AE 12: FINANCE AND FINANCIAL REPORTING

Course Type: Core

Module structure:

1. Principles of Finance

Basic concepts, investment and asset management; objectives of an organization; Role and effects of capital markets, agent theory; theory of maximization of shareholder wealth; types of business entity; private and public companies; joint stock company; pros and cons of limited company; medium (hire purchase, credit sale, leasing and bank loans) and short (bank ODs, trade credit, factoring, bills of exchange, commercial paper) term company finance

2. Principles of Taxation and Investment Analysis

Basic principles of corporate and personal taxation, taxation of capital gains, double taxation relief, principle forms of financial instruments issued and used by companies-debenture stocks, unsecured loan stocks, Eurobonds, preference shares; ordinary and convertible shares, floating rate notes, options issued by companies etc.; corporate and private debt, credit derivatives, financial futures, options and currency swaps used by non-financial company; methods of obtaining quotation for securities; effect of taxation on capital structure used by a company, dividend policy on the market valuation of a company; venture capital and hedge funds

3. Capital Structure and Financial Accounts

Capital structure, weighted average cost of capital, Project evaluation methods, methods to evaluate risky investments: profitability trees, simulation and certainty equivalents

4. Financial Reporting

Fundamental accounting concepts, balance sheets, profit and loss account, cash flow statement; insurance company accounts, consolidated accounts, depreciation used in company account, reserves/share premium account, revaluation reserves; effects of interest rate movements on a highly geared company; capital structure and financial leverage; ratio analysis- price earnings ratio, profitability; liquidity and efficiency; short coming historical cost accounting

5. Assessment of Capital Investment Projects

Methods to determine the viability of capital investment projects, choice discount rate; methods for identifying risks, techniques for ascertaining the profitability of occurrence of different risks over varying timescales and financial impact of occurrence; techniques for ascertaining distribution of financial outcomes of a capital project

Reference Books

- Brealey, R.A. and S.C Myres, Principles of Corporate Finance, McGraw-Hill, sixth edition, 1999
- Geoffrey Holmes, and A. Sugden, Interpreting Company Reports and Accounts, Prentice Hall, seventh edition, 1999
- Samuels, J.M., F.M. Wilkes and B. Shaw, Management of Company Finance, International Thomson, sixth edition, 1995.

AE 13: ADVANCES IN LIFE AND HEALTH INSURANCE

Module structure:

1. Life Insurance

Basic mechanism, types of life insurance: permanent, whole, universal, endowment, joint, group; premium principles and their properties; life tables, different forms: cohort, current, single and multiple decrements, functions of life tables, survival distribution, DeMoivre law, curtate future life time, uniform distribution of deaths and constant force of mortality, aggregate table, select and ultimate table, Gompertz-Makeham mortality laws.

2. Life Insurance Products I

Cash flow valuation, annuities, amortization, and sinking funds, valuing contingent payments, status, joint life status, survival function, the life status, net premium and the insurances payable at the time of death, n- year endowment and pure endowment, term insurance, whole life, deferred term insurance, whole life increasing monthly, n-year term increasing annually, n- year term decreasing annually, n year term decreasing monthly, uniform distribution of death assumption and the insurance products at curtate age

3. Life Insurance Products II

Insurance models including expenses, expense loaded premium (or the gross premium), modified equivalence principle, multiple lives, common shock model, multiple decrement models, with and without-profits endowment assurance, unit-linked products and policies, Group endowment assurances, withdrawal risk, contract design, group term assurance, surrender values, unit pricing, internal unit-linked fund, equity principle of unit pricing, appropriation and expropriation prices, offer and bid basis, asset shares for life insurance contracts, actuarial funding, conditions for and aim of actuarial funding, actuarial funding factors and unit fund profits

4. Health Insurance I

Principal terms in health care, types of health insurance contracts: critical illness, income protection and disability income insurance, long term care insurance, hospital cash, private medical insurance, group and individual covers, state's role in the provision of alternative or complementary health care; lump sums and regular incomes, flat-rated and earnings related, different viewpoints for the retired, for the employed, for children, simpler methods of funding

5. Pricing Health Care Insurance

Data availability, assumptions, underwriting, standard and sub-standard risk, group risk assessments, applications of mortality tables for health insurance, rating process, measures of morbidity experience, continuance tables, net level premiums, loss ratios, factors affecting premiums, provider payment arrangements, calculations of claim costs, accidental death and dismemberment, premium rate variables, managed care pricing, HMO rating, policy reserves

Reference Books

- Institute of Actuaries (2008), Life insurance, Reading for the Subject ST2, London.
- Institute of Actuaries (2008), Health and Care, Reading for the Subject ST1, London.
- Harrington, S. and G. Niehaus, Risk Management and Insurance, second edition, Tata McGraw-Hill, 2004.
- Rajeda, G., Principles of Risk Management and Insurance, eighth edition, Pearson Education, 2004

AE 14: FINANCIAL DERIVATIVES

Module structure:

1. Introduction to Derivatives

Derivative markets and trading; Types of Derivatives; Arbitrage, Speculation and Hedging; Forward and future contracts; Options; Swaps; Real options

2. Forward and Future Contracts

Defining, pricing, using, and valuing forward contracts; cost-of-carry. Hedging using Forward and Future Contracts, Optimal Hedging Strategies, Cross Hedging and Hedge Effectiveness.

3. Introduction to Options

Call and put options; option terminology, hedging with Options and Put-Call Parity Option Strategies using Protective puts; collars; synthetic long/short positions Spreads and combinations

4. Derivative Pricing

The Binomial-Tree and Risk Neutral Pricing, Derivative Pricing in the Binomial-Tree Model Dynamic replication; delta-hedging; self-financing portfolios; calibrating the binomial model; pricing calls and puts.

5. The Black-Scholes-Merton Model (BSM)

Stochastic process and Brownian motion, understanding, using, and deriving the BSM-model for non-dividend paying stocks; implied volatility and its Greeks - Delta, Gamma, and Theta of derivatives in the BSM-model.

Reference Books:

- Hull, J. Options, Futures and other Derivatives, tenth edition, Prentice Hall
- Brealey, R. and S. Myers, Principles of Corporate Finance, eighth edition, New York, McGraw Hill
- Copeland, T.E., Weston, J.F., Shastri, K. and Education, P. (1983) Financial Theory and Corporate Policy (Vol. 3). Addison-Wesley, Massachusetts.

AE 16: RISK MODELS

Module structure:

1. Decision Theory and Loss Distributions

Prior and posterior distributions; sequential decision procedure and its risk functions; minimax and Bayes criterion; MGFs of loss distributions: gamma, exponential, Pareto and generalized Pareto, Normal and log Normal, Weibull and Burr; deductibles and retention limits; reinsurance; excess of loss insurance; estimation of parameters of failure time using MLE and MOM

2. Bayesian Statistics and Credibility Theory

Bayes theorem; Posterior Distribution; loss function to derive Bayesian estimates of parameters; credibility theory; Bayesian credibility-Poisson/gamma model; Baye's thermo, a Bayesian approach to the updating of claim frequency rates; no claim discount; the credibility premium

3. Rating Systems

Credit rating for mortgages; experience rating system based on claim frequency; delay triangle techniques, chain ladder method, inflation adjustment, development factors, estimating outstanding claims

4. Construction of Risk Models

Models for short term insurance contracts, calculations of MGFs and moments for risk models: the sum of N independent random variables when N has a binomial, Poisson and geometric distributions; compound binomial, Poisson and negative binomial random variables; aggregate claim distribution for short term insurance contracts

5. Ruin for a Risk Model

Ruin for a risk model, aggregate claim process, probability of ruin in infinite/finite and continuous and discrete time and state; relation between different probabilities of ruin; adjustment coefficients and Lundberg's inequality

Reference Books

- Ross, S.M., Introduction to Probability Models, Academic Press, seventh edition, 2000
- Berject, J. Statistical Decision Theory and Bayesian Analysis.
- Hossack, P. and Zehnwirth, Introductory Statistics with Applications in General Insurance, Cambridge University Press
- Hogg, R.V. and S.A. Klugman, Loss Distributions.

AE 22: FIXED INCOME SECURITIES

Module structure:

1. Introduction to Fixed Income Securities

Time value of money, discount factors, the law of one price, arbitrage, bond prices, spot prices, STRIPS, coupon bonds, definition and interpretation of yield-to-maturity, coupon effect, yield- to maturity and spot rates and forward rates

2. Measure of Price Sensitivity and Hedging

One-factor measure of price sensitivity, modified and Macaulay duration and convexity, par bonds and perpetuities, measure of price sensitivity based on parallel yield shift, bond immunization, hedging strategies, volatility weighted hedging and regression based hedging

3. Term Structure Models

The science of term structure models, normally distributed rates and zero drift models, time dependent drift - Ho-Lee model, the mean reversion model: Vasicek model, the volatility models:
the Cox-Ingersoll-Ross model

4. Multi-Factor Term Structure Models

Motivation for principal component models, the two factor models, properties of the two factor models, multi-factor models, trading with term structure models and case studies, hedging to the model versus hedging to the market

5. Fixed Income Market in India

An introduction to the Indian debt market, the government securities market, bond, T-bills, the corporate bonds, commercial papers, repos, the trading mechanism in the NSE-WDM, regulations in the bond market

Reference Book

- Fabozzi, F. Bond Markets, Analysis and Strategies, Prentice Hall, 2004
- Tuckman, B. Fixed Income Securities, Willey Finance, 2002
- Copeland, T. E. and J. F. Weston, Financial Theory and Corporate Policy, Addison Wesley, 1992
- Brealey, R. and S. Myers, Principles of Corporate Finance, fifth edition, New York, McGraw Hill, 1997

AE 23: RISK ANALYSIS AND MANAGEMENT

Module structure

1. Project Risk Management
Overview, different dimensions of risk, nature of risk management, definition, benefits of risk management, concepts and processes, identification and assessment of risks: operational, strategic, hazard, economic and financial risks, possible threats to risk-management
2. Phases of Risk Management and Identification
Definitions: process and stages of risk management, success criteria, stakeholder and stakeholder analysis, constraint analysis, SWOT analysis, Delphi technique, qualitative risk management: definition, probability and impact assessment, risk description and breakdown, uses of various techniques
3. Risk Analysis
Introduction: exposures of human assets, hazard risk management, crime risks, exposures of property/physical assets, strategic risk management, managing international risks, economic risk management, integrating risk types and exposures
4. Financial Risk
Statistical concepts for financial risk: probability distribution and its application, decision tress, expected value and correlation, financial risk management, difference between qualitative and quantitative risk-management, financial products and fundamentals of pricing
5. Market and Credit Risk
Definition, managing market risk, current issues in market risk, Value at Risk, advanced techniques for managing market risks, risk and diversification benefits, credit exposure and managing credit risk, financial distress and prediction of bankruptcy, impact of Basel II

Reference Books

- Vaughan, E. J., Risk Management, Wiley, 1998
- Doherty, N., Integrated risk management: techniques and strategies for managing corporate, McGraw-Hill, 2000
- Jorion, P., Financial Risk Management Handbook, Wiley, 2003
- Chapman, R.J., Simple Tools and Techniques for Enterprise Risk Management, Wiley, 2006

AE 24: FINANCIAL REGULATIONS AND BANKING SUPERVISION

Module structure:

1. Financial Regulation

Asymmetric information and the rationale for regulation of financial institutions and market, financial market fragility, Evolution of regulatory policies; Cross country Experiences.

2. Indian Capital Markets

Structure of primary and secondary markets, dematerialization, depositories, credit rating of financial instruments, financial institutions: development financial institutions, non-banking financial intermediaries, LIC of India and UTI, mutual funds, venture capital, bank-assurance

3. Financial Sector Reforms

Banking sector reforms-phase -phase out of statutory precyton interest rate deregulation etc.- Indian capital market integration, foreign institutional investors, impact of exchange rate variability in a liberalized regime, Issues of GDRs, ADRs

4. Banking Regulation and BIS

Banking regulation act 1949, financial stability, banking regulation; Basel norms- Capital Adequacy, Income recognition; provisioning; statutory reserve requirement, CAMELS; liquidity risk and contagion market discipline: issues and evidence market discipline in emerging economies: beyond bank fundamentals; conduct of monetary policy;

5. Risk Management

Various Types of Risks in banking and trading banks; Management of Credit Risks; Market Risks, Liquidity Risks, and Operational Risks-General Principles of Bank Management- Solvency, liquidity and profitability considerations.

Reference Books

- Houthakker, H.S. and Williamson, P.J. The Economics of Financial Markets, Oxford University Press, 1996.
- Krugman, P. and Obstfeld, M. International Economics, Theory and Policy, sixth edition, Addison - Wesley, 2003.
- Herring, R. and Litan, R.E. Financial Regulation in the Global Economy, Brookings Institution Press, 1995.
- Howells, P. and Bain, K. Financial Markets and Institutions, Fifth Edition, Pearson Education, 2007

AE 25: APPLIED MACRO AND FINANCIAL ECONOMETRICS

Module structure:

1. Univariate Time-series Models

Introduction to stationary processes, autocovariance functions, autocorrelation and partial autocorrelation, autoregressive and moving average models, conditions for stationary and invertible process, Box-Jenkins approach, forecasting.

2. Multivariate and Multiple Equation Models

Motivation for multivariate model, Autoregressive Distributive Lag Models, Simultaneity and motivation for Vector autoregressive (VAR) models, Testing for order of VAR models, Block significance and tests for causality including Granger causality, Forecasting, Impulse response function, Variance decomposition.

3. Modeling Non-Stationary Time-series processes

Deterministic and stochastic trends, Integrated process and random walk, random walk with drift,

Unit root and tests for unit root- Dickey-Fuller and Augmented Dickey Fuller tests, Phillips-Perron Test and KPSS test, Unit Roots and Structural Breaks, Unit roots in regression residuals and spurious regression, Cointegration and its testing using Engel-Granger method, Lead-lag and Long Run relationships, Characteristic Root, Rank and Cointegration, Testing for and estimating cointegrating systems using the Johansen method based on VARs, Vector Error Correction Models.

4. Modeling volatility clustering

Volatility-Meaning and measurement, Volatility clustering, Econometric models of volatility, Conditional heteroscedasticity in ARMA models, Estimation and Testing for ARCH and GARCH models for volatility clustering in economic time-series, multivariate regression models and conditional heteroscedasticity, Asymmetric GARCH models-GJR model and EGARCH.

5. Static and Dynamic Panel Data Models

Introduction to panel data, pooled repeated cross-section model, within and between estimators, one- way fixed effects model, fixed effects model using least squares dummy variable approach, random effects model, time fixed effects, Tests of hypothesis for pooled or fixed effects model, pooled and or random effects models (Breusch-Pagan Lagrange Multiplier Test) and fixed or random effects (Hausman test), Introduction to dynamic Panel data models, Arellano and Bond Estimator, The Arellano and Bover Estimator, The Blundell and Bond System GMM Estimator.

Reference Books

- Baltagi, Badi. *Econometric Analysis of Panel Data*, 5th Edition, Wiley, 2013.
- Brooks, C., *Introductory Econometrics for Finance*, 3rd Edition, Cambridge University Press, 2014.
- Enders, W., *Applied Econometric Time Series*, second edition, John Wiley and Sons, 2006.
- Hamilton, J. D., *Time Series Analysis*, Princeton University Press, 1994.
- Pesaran, H.M. *Time Series and Panel Data Econometrics*, Oxford University Press, 2015

In each of the topics, examples from financial economics and macroeconomics will be discussed based on recent journal articles and working papers and the reading material will be shared with the students by the course instructor.

AE 26: ECONOMICS OF GLOBAL CLIMATE CHANGE

Module structure:

1. Introduction
Science of climate change; global and regional climate predictions; uncertainty in science; physical impacts of climate change – agriculture, sea level rise, health, extreme events; policy debate
2. Climate Change Policy – Mitigation
Efficiency, public goods, externalities; environmental policy instruments – emissions trading, carbon tax, emission trading versus tax; stock pollutants and discounting; decisions under risk and uncertainty;
3. Integrated Assessment
Costs and benefits of greenhouse gas mitigation; integrated assessment models; simulation exercises based on DICE model and its variants; sensitivity and uncertainty analysis; Stern review
4. Climate Change Policy – Adaptation
Climate change impact assessment – applications for agriculture, sea level rise and health; vulnerability assessment; economics of adaptation; measurement of adaptation cost; issues in financing adaptation; case studies
5. Climate Change Negotiations and Equity
Criteria for distribution of emission reduction burden; distribution criteria for adaptation fund; inter and intra-generational equity issues; discounting in climate change context

Reference Books

- Perman, R., Ma. Y., Common, M., Maddison, D., Mcgilvray, J., Natural Resource and Environmental Economics, Pearson Education Limited, 2011 (4th Edition).
- Intergovernmental Panel on Climate Change – Fifth Assessment Report, 2011
- Ackerman, F. and E.A. Stanton, Climate Economics – The State of the Art, Routledge, 2013.
- Stern, N., The economics of climate change – The Stern Review, Cambridge University Press, 2006.
- Nordhaus, W.D., Managing the Global Commons: The Economics of Climate Change, MIT Press, 1994.
- Toman, M.A., U. Chakravorty, and S. Gupta, India and Global Climate Change: Perspectives on Economics and Policy from a Developing Country, RFF Press, 2003.
- Nordhaus, W. (2008), A Question of Balance: Weighing the Options on Global Warming Policies, Yale University Press, New Haven

AE 27: GAMES AND INFORMATION

Module structure:

1. Static Games of Complete Information
Rational Choice Theory, Strategic form or normal form games; solution concept: Iterated deletion of strictly and weakly dominated strategies; Best Response Functions and Nash equilibrium, mixed and pure strategies; Applications in Industrial Organisation, Labor Market and Political Economy.
2. Dynamic Games of Complete Information
Extensive forms, backward induction, Application: Stackelberg Model of Duopoly, Sequential Bargaining, Finitely and infinitely repeated games, Trigger Strategies, Collusion between Cournot
Duopoly, Dynamic games of complete but imperfect information, Subgame Perfect Nash Equilibrium, Bargaining with complete information, ultimatum game, hold up game, bargaining as an extensive game: Rubinstein model, axiomatic bargaining: Nash bargaining solution, applications
3. Static Games of Incomplete Information
Incomplete Information, Notion of type and strategy, Static Bayesian Games and Bayesian-Nash equilibrium; Examples of Bayesian Nash equilibrium in Industrial organization under Asymmetric Information, Application: Mixed Strategy Revisited, Mechanism Design, 1st price and 2nd price sealed bid Auctions
4. Dynamic Games of Incomplete Information
Perfect Bayesian Equilibrium, Conditional belief about types, Sequential Rationality, Consistency of Belief, Pooling and Separating Equilibria, The basic Signaling game, Applications of Signaling game
5. Introduction to Cooperative Games
Elements of cooperative games, coalition, transferable utility, super additivity theorem, Solution Concept: core, Examples of Core, Shapley-Value.

Reference Books

- Osborne, M. J., An Introduction to Game Theory, Oxford University Press, 2003
- Gibbons, R., A Primer in Game Theory, Harvester-Wheatsheaf, 1992
- Fudenberg, D and J. Tirole, Game Theory, MIT Press, 1991
- Osborne, M. J. and A. Rubinstein, A Course in Game Theory, MIT Press, 1994
- Andreu Mas-Colell, Michael Whinston and Jerry Green Microeconomic Theory, Oxford University Press

AE 28: ADVANCED TECHNIQUES IN FINANCE

Module structure:

1. Kalman Filters
Introduction to Kalman filters, local level model, local linear trend model, local level model with explanatory variable and intervention variable, confidence interval, filtering and prediction, forecasting
2. Estimation, Testing and Resampling
Smoother and simulation smoother techniques, linear Gaussian state space model, choice of simulation method, Wavelet estimation, goodness of fit tests, tests for cycles, re-sampling in state space models, Bayesian parameter estimation, applications
3. Bootstrap
Introduction, estimation of standard error, parametric bootstraps, number of bootstrap replications, application of bootstrap in regression models, bootstrap pairs, bootstrap residuals, examples, confidence intervals based on bootstrap
4. Hypothesis Testing and Bootstrap Computation
Testing hypothesis with bootstrap, two sample problems, testing multimodality, cross validation, post sampling adjustment, bootstrap bias, bootstrap variance, applications of bootstrap computations
5. Bootstrap Bioequivalence
Confidence intervals, power calculations, Fieller's interval

Reference Books

- Harvey, A., S.J. Koopman, and N. Shephard, State Space and Unobserved Components Model, Theory and Applications, Cambridge University Press, 2004
- Efron, B., and R. Tibshirani, An Introduction to Bootstrap, Chapman Hall, 1993
- Mooney, C. and R. D. Duval, Bootstrapping: A Nonparametric Approach to Statistical Inference, Sage, 1993
- Friedman, J., T. Hastie, and R. Tibshirani, Additive Logistic Regression- A Statistical View of Boosting, Annals of Statistics, 2000

AE 29: INTERNATIONAL TRADE

Module structure:

1. Introduction
Evolution of trade and trade theories, Production function, cost function, comparative advantage, Ricardian trade model
2. General Equilibrium Trade Theory
Heckscher-Ohlin, Stolper-Samuelson and Rybzynski Theorem and Factor Price Equalization
Theorem, Empirics and Leontief's Paradox, HOV model, Leamer's and Trefler's Theorem, Specific-factors model
3. Trade and Technology
Role of Technology in the Theory of International Trade, Product-Cycle Model, Technological Gap Model
4. New Trade Theories: Imperfect Competition and Intra-industry trade
Monopolistic and oligopolistic competition models of trade, Love-for-variety-preferences, Scale economies, product differentiation and the pattern of trade, Gains from Trade when Firms Matter
5. Trade Policy and Political Economy
Normative issues of welfare, Policy interventions in terms of tariffs, taxes and subsidies, Voluntary import expansion and export restrictions, Metzler paradox, Trade and growth, Immiserizing growth, Multilateral trade agreements and political economy: World Trade Organization

Books and Suggested Readings:

- Jagdish Bhagwati, Arvind Panagariya and T.N. Srinivasan (1998) Lectures on International Trade, MIT Press, 2nd edition.
- Robert C. Feenstra (2004) Advanced International Trade: Theory and Evidence, Princeton University Press, (Indian edition 2007).
- World Trade Report
- Ronald W. Jones (1970) "The Role of Technology in the Theory of International Trade", in Raymond Vernon ed. The Technology Factor in International Trade, NBER and Columbia University Press: 73-90
- Don Davis (1995) "Intra-industry trade: a Heckscher-Ohlin-Ricardo Approach", Journal of International Economics, Volume 39(3-4): 201-226.
- Marc J. Melitz and Daniel Trefler (2012) "Gains from Trade when Firms Matter", Journal of Economic Perspectives, Volume 26(2): 91-118.

Additional readings such as recent journal articles, working papers and other reading material will be shared with the students by the course instructor as and when required.

AE 30: DEVELOPMENT ECONOMICS

Module structure:

1. Economic Development – an Overview
Concepts, approaches and dimensions of development and their indicators; measurement issues; income growth as development, factors influencing growth - human capital and demographic characteristics, structure and openness of the economy, path dependence- expectations- complementarities, political institutions and governance; distribution of income – economic inequality, its measurement and interrelationship income growth, poverty measures and underdevelopment
2. Theories of Economic Growth
Balanced versus imbalanced growth, Harrod-Domar model, Solow model, technical progress, growth convergence; new growth theories – human capital and growth, total factor productivity; comparative analysis; role of resources, technology and institutions
3. Human Resources & Labour Markets
Impact of nutrition, health, education, population growth on human capital; segmented labour markets, migration, unemployment (Harris-Todaro model, labour turnover model, efficiency wage hypothesis) sub- optimal employment, disguised unemployment, informal labour markets
4. Agriculture – Markets for land, credit and water
Land size & productivity, ownership, tenancy, contractual arrangements, risk sharing mechanisms, improvements in land; formal and informal rural credit markets, lender's risk hypothesis, collateral, default and enforcement, limits to credit and insurance access, micro-finance; formal and informal water markets
5. Institutions and Political Economy
Institutions and its allocation of property rights for decision-making across different governance modes and their implications for economic efficiency & equity, Social welfare institutions and economic development, Economic consequences of different forms of government and electoral rules, empirical strategies of comparative political economy; role of state in provision of public goods; political economy aspects of property rights; corruption and its impacts economic development and potential strategies to tackle corruption

Reference Books

- Ray, D., Development Economics, Princeton University Press, 1998
- Basu, K., Analytical Development Economics, MIT Press, 2003
- Bardhan, P. and C. Udry, Development Microeconomics, Oxford University Press, 1999
- Agenor, P-R., and P. J. Montiel, Development Macroeconomics, Princeton University Press, 2008
- Hayami, Y. and Y. Godo, Development Economics: From Poverty to Wealth of Nations, Oxford University Press, 2005
- Hendrik Van Den Berg and Joshua J Lewer: International Trade and Economic Growth, Prentice Hall of India
- Perkins, Radelet, Lindauer and Block, Economics of Development (seventh edition), W.W.Norton& Company, 2012

AE 31: SUSTAINABLE DEVELOPMENT

Module structure:

1. Introduction
Need for studying the economics of sustainable development; meaning of sustainable development – Comparison with static and dynamic economic efficiency; Weak versus strong sustainability; Rawls and Solow Sustainability, role of discounting, Inter- and Intra-generational equity and sustainability
2. Valuing Market and Non-market Ecosystem and Social Services
Uses of monetary valuation; Cost-benefit analysis; Techniques of monetary valuation – recap; Applications
3. Measuring Sustainable Development
Defining conventional gross net product (GNP); modifying GNP for missing (non-market) values – Green GNP; genuine savings; critical natural capital concerns and strong sustainability
4. Sustainable Development – Ecological Economics
Precautionary Principle; biodiversity and precautionary principle; economic growth and natural carrying capacity
5. Sustainable Development – Visions, Principles, and Operational Rules
Indicators of Sustainability and Sustainable Development Goals; Neoclassical economic growth, Inclusive and comprehensive wealth and sustainability; social capital, community sustainability and environmental justice; trans-boundary environmental degradation; global economic integration and environment

Reference Books

- Pearce, D. and E. Barbier, *Blueprint for a Sustainable Economy*, Earthscan, 2000.
- Daly, H.E., *Beyond Growth: The Economics of Sustainable Development*, Beacon Press, 1996.
- Rogers, P. K.F. Jalal and J.A. Boyd, *An Introduction to Sustainable Development*, Earthscan, 2008
- Deb, D. *Beyond Developmentality: Constructing Inclusive Freedom and Sustainability*, Daanish Books, 2009
- Sengupta, R. (2012), *Ecological Limits and Economic Development*, Oxford University Press, Delhi
- Murty, M.N. (2009), *Environment, Sustainable Development, and Well-being: Valuation, Taxes and Incentives*, Oxford University Press, Delhi
- UNU-HIS, UNEP, *Inclusive Wealth Report 2012: Measuring Progress Towards Sustainability*, Cambridge University Press, 2012.
- UNU-HIS, UNEP, *Inclusive Wealth Report 2014: Measuring Progress Towards Sustainability*, Cambridge University Press, 2014

AE 32: STOCHASTIC CALCULUS AND QUANTITATIVE FINANCE

Module structure

1. Stochastic Calculus
Basics of stochastic processes, poisson process Brownian motion process and its varied generalisations, Geometric Brownian motion, Analysis of second order processes, Ito integral and Ito lemma with applications, Kolmogorov equations, Jump process, Calculus for jump processes, change of measure, basics of Levy stochastic calculus.
2. Stochastic Tool-kit for finance
Martingales, Martingale representation theorem, stopping time, stopped process, first passage time, Doob's optimal stopping theorem, Girsanov theory, Arc-sine law, pricing kernel as a Martingale, Risk neutral analysis, sharpe ratio.
3. Valuation of asset prices
Stochastic characterisation of complete and incomplete markets, Forward and future contracts, binomial tree model, Black-Schole's theory and applications, Put-call parity, Implied volatility, Exchange options, Currency options, American options, Sensitivity analysis (Greeks)
4. Interest rate models and derivatives
Mean-reverting processes, O-U process, Square root process, Factor models-the Merton model, The Vasicek model, The Cox Ingersoll-Ross model, Heath-Jarrow-Merton model, Pricing of Bonds, Stochastic interest rate, Rate of return and yield curve.
5. Further option theory
Swaps, Caps, Floors, Swaptions, Forward LIBOR models, Barrier options, Look back option, Calibration, Levy process as stock price model, Stochastic volatility models, Heston model and Wiggins' model, ARCH and GARCH models and their suitable extensions in diffusion.

Reference Books

- Shreve S.E.: Stochastic calculus for finance volume 2-continuous time models, springer Verlag 2004
- J.C. Hull and Sankar Shan Basu: Options, futures and other derivatives-Prentice Hall 2010
- Jamil Baz and George Chacko: Financial derivatives-Cambridge university press 2009
- Paul Wilmott, Sam Howison and Jeff Dewynne: The Mathematics of financial derivatives: Cambridge university press 2007
- David Apple Baum: Levy processes and stochastic calculus-Cambridge university press 2004
- Yuh-Dauh-Lyuu: Financial Engineering and Computation- Cambridge university press 2002

AE 33: ECONOMICS OF HEALTH AND ENVIRONMENT

Module structure

1. Introduction

Review of market failures; statistical value of life and health – empirical estimates of statistical value of life; disability adjusted life years

2. Environmental Effects on Health

Health production function; exposure, dose and response; indoor and outdoor air pollution; effects of air pollution on children, adults; effects of climate variability and climate change on mortality and morbidity; environmental toxicology; environmental carcinogenesis; waterborne diseases; municipal, industrial and hazardous waste – health implications

3. Medical Production of Health

Individual as producer of health; characteristics of health services and production; design of health-related insurances; role of the physician as a producer of health; healthcare organisation and funding; effects of health care expenditure on health; market for pharmaceuticals

4. Market Failure in the Provision of Health Care

Adverse selection in insurance markets; moral hazards, externalities, and other market failures in health care; problems of risk and uncertainty; unequal information; imperfect competition; equality in health care

5. Health and Environmental Policy – Inter-linkages

Global policy initiatives: national environmental and health action plans; Health impacts from

Air and water pollution; Variations in the weather and impact on mortality; disease incidence; Economic and health effects of weather related disturbances, Environmental health; global changes in environment and the third world.

Reference Books

- Zweifel, Peter, Friedrich Breyer, and Mathias Kifmann. Health economics. Springer Science & Business Media, 2009.
- Duflo, E., Greenstone, M. and R. Hanna. 2008. Indoor Air Pollution, Health, and Economic Well-Being, Surveys and Perspectives Integrating Environment and Society
- Gilbreath, J. 2007. The Economics of Better Environmental Health, Environmental Health Perspectives, 2007 2. *Hubbell, B. J. 2006. Implementing QALYs in the Analysis of Air Pollution Regulations, Environmental and Resource Economics, 34(3), 34:365–384
- Prüss-Üstün A., C. Mathers, C. Corvalán and A. Woodward. 2003. Introduction and Methods: Assessing the Environmental burden of disease at national and local levels, WHO.
- Yassi, A., T. Kiellstrom, T. de Kok, and T.L. Guidotti, Basic Environmental Health, Oxford University Press, 2001

- Confalonieri, U., B. Menne, R. Akhtar, K.L. Ebi, M. Hauengue, R.S. Kovats, B. Revich and A. Woodward, 2007: Human health. Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change,
- M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press.
- Clasen, T. F. and L. Haller. 2008. Water Quality Interventions to Prevent Diarrhoea: Cost and Cost- Effectiveness, Public Health and the Environment, World Health Organization,
- Phelps, C. Health Economics, 4th edition, Pearson Education, 2009
- Nadakavukaren, A. Our Global Environment: A Health Perspective, Waveland Press, 2005.

AE04 MATHEMATICS FOR ACTUARIES

Course Type: Core

IFoA Alignment: CM1

Module Structure

1: Functions for Calculus in Economics

Set theory - elements, types, operations, cartesian product, relations, Real intervals, Functions and limits, Differentiation rules, Higher-order derivatives, Taylor series, Applications in optimisation

2: Integral Calculus and Multivariate Calculus

Indefinite and definite integrals, Techniques of integration, Double integrals, Partial derivatives, Multivariate optimisation

3: Time Value of Money

Simple and compound interest, Nominal and effective interest rates, Discount factors, Accumulation functions, Force of interest

4: Cash Flow Models

Equation of value, Present value and future value, Deterministic cash flow modelling, Inflation and real interest rates

5: Annuities, Loans and Bonds

Level annuities, Increasing and decreasing annuities, Loan amortization schedules, Outstanding balances, Bond pricing, Yield rates, Duration and convexity, Term structure of interest rates

Recommended Reading

Primary Textbooks

- Simon, C. P., & Blume, L. (1994). *Mathematics for Economists*. W. W. Norton & Company.
- Kellison, S. G. (2009). *Theory of Interest* (3rd ed.). McGraw–Hill.
- Garrett, S. (2013). *An Introduction to the Mathematics of Finance*. Butterworth–Heinemann.

Supplementary References

- Chiang, A. C., & Wainwright, K. (2005). *Fundamental Methods of Mathematical Economics* (4th ed.). McGraw–Hill.
- Broverman, S. A. (2017). *Mathematics of Investment and Credit* (5th ed.). ACTEX Academic Publishers.
- de la Fuente, A. (2000). *Mathematical Methods and Models for Economists*. Cambridge University Press.
- Campolieti, G., & Makarov, R. N. (2014). *Financial Mathematics: A Comprehensive Treatment*. CRC Press.

AE18 LIFE CONTINGENCIES I

Course Type: Core

IFoA Alignment: CM1, CS2

Module Structure

1: Functions in life insurance mathematics

Survival functions, Force of mortality, Curtate and complete future lifetime

2: Life Tables

Construction of life tables, Select and ultimate mortality, Graduation methods

3: Life Insurance Benefits

Term insurance, Whole life insurance, Endowment insurance

4: Life Annuities

Whole life annuities, Temporary annuities, Deferred annuities

5: Net Premium Valuation

Net premium principle, Expected present value calculations

Recommended Reading

Primary Textbooks

- Dickson, D. C. M., Hardy, M. R., & Waters, H. R. (2020). *Actuarial Mathematics for Life Contingent Risks* (3rd ed.). Cambridge University Press.
- Promislow, S. D. (2015). *Fundamentals of Actuarial Mathematics* (3rd ed.). Wiley.
- Slud, E. V. (2006). *Actuarial Mathematics and Life-Table Statistics*. University of Maryland.

Supplementary References

- Bowers, N. L., Gerber, H. U., Hickman, J. C., Jones, D. A., & Nesbitt, C. J. (1997). *Actuarial Mathematics*. Society of Actuaries.
- Jordan, C. W. (1967). *Life Contingencies*. Society of Actuaries.
- Dickson, D. C. M. (2013). *Life Insurance Mathematics*. Springer.

AE19 PROBABILITY AND RISK MODELLING

Course Type: Core

IFoA Alignment: CS1 → CS2 Transition

Module Structure

1: Probability Structures for Actuarial Modelling (CS1 Foundation)

Probability spaces: sample space, events and probability measures, Random variables and distribution functions, Expectation, variance and higher moments, Moment generating functions, Indicator functions and their actuarial applications, Law of total probability and Bayes' theorem in actuarial contexts

2: Conditional Expectation and Dependence (CS1 Extension)

Joint, marginal and conditional distributions, Conditional expectation and conditional variance, Law of iterated expectations, Covariance and correlation, Independence and conditional independence, Transformations and functions of random variables

3: Limit Theorems in Risk Modelling (CS1 Core)

Review of sampling distributions, Law of large numbers, Central limit theorem, Approximation of distributions, Applications to aggregate claims and portfolio risk

4: Introduction to Stochastic Processes (CS2 Preparation)

Definition of stochastic processes, Index sets and state spaces, Discrete-time stochastic processes, Continuous-time stochastic processes, Random walks and simple counting processes, Interpretation of stochastic models in insurance

5: Aggregate Risk Models (CS2 Preparation)

Frequency and severity models, Aggregate claims model $S = \sum_{i=1}^n X_i$, Compound distributions, Collective risk model, Introduction to ruin concepts in insurance portfolios

Primary Textbooks

- Ross, S. M. (2014). *Introduction to Probability Models* (11th ed.). Academic Press.
- Pitman, J. (1993). *Probability*. Springer.
- Grimmett, G., & Stirzaker, D. (2001). *Probability and Random Processes* (3rd ed.). Oxford University Press.
- Dickson, D. C. M. (2016). *Insurance Risk and Ruin*. Cambridge University Press.

Supplementary References

- Klugman, S. A., Panjer, H. H., & Willmot, G. E. (2012). *Loss Models: From Data to Decisions* (4th ed.). Wiley.
- Rolski, T., Schmidli, H., Schmidt, V., & Teugels, J. (2009). *Stochastic Processes for Insurance and Finance*. Wiley.
- Resnick, S. I. (1992). *Adventures in Stochastic Processes*. Birkh user.
- Williams, D. (1991). *Probability with Martingales*. Cambridge University Press.
- Mikosch, T. (2009). *Non-Life Insurance Mathematics: An Introduction with Stochastic Processes*. Springer

AE20 LIFE CONTINGENCIES II

Course Type: Core

IFoA Alignment: CM1 and CM2

Module Structure

1: Reserves

Concept and purpose of reserves in life insurance, Prospective and retrospective reserves, Recursive reserve calculations, Net premium reserves, Gross premium reserves, Expense reserves, Reserve bases and valuation assumptions, Statutory reserves and regulatory consideration, Applications in solvency and financial reporting

2: Profit Testing

Concept of profit testing in life insurance, Cash flow projections for life insurance policies, Profit signatures, Internal rate of return and present value of profits, Sensitivity analysis, Impact of mortality, interest rates and expenses, Product pricing and profitability analysis, Applications in product design and risk management

3: Multiple State Models

Introduction to multiple state actuarial models, State transition models, Transition intensities, Kolmogorov differential equations, Applications in disability insurance, Applications in health insurance, Markov and semi-Markov models in life insurance, Calculation of benefits and reserves under multi-state models

4: Policy Alterations

Policy alterations in life insurance contracts, Paid-up policies, Surrender values, Policy loans, Conversion options, Policy modifications and adjustments, Impact of alterations on reserves and benefits, Regulatory considerations

5: Embedded Options

Embedded options in insurance contracts, Guaranteed minimum benefits, Interest rate guarantees, Surrender options, Policyholder behavioural options, Valuation of embedded options, Impact on product pricing and risk management, Overview of option pricing approaches in actuarial practice

Primary Textbooks

- Dickson, D. C. M., Hardy, M. R., & Waters, H. R. (2020). *Actuarial Mathematics for Life Contingent Risks* (3rd ed.). Cambridge University Press.
- Gerber, H. U. (1997). *Life Insurance Mathematics* (3rd ed.). Springer.
- Bowers, N. L., Gerber, H. U., Hickman, J. C., Jones, D. A., & Nesbitt, C. J. (1997). *Actuarial Mathematics*. Society of Actuaries.

Supplementary References

- Hardy, M. R. (2003). *Investment Guarantees: Modeling and Risk Management for Equity-Linked Life Insurance*. Wiley.
- Olivieri, A., & Pitacco, E. (2015). *Introduction to Insurance Mathematics: Technical and Financial Features of Risk Transfers*. Springer.
- Norberg, R. (1995). *Life Insurance Mathematics*. Heriot-Watt University.
- Dickson, D. C. M. (2013). *Life Insurance Mathematics*. Springer.

AE38 GENERAL INSURANCE MODELLING

Course Type: Core

IFoA Alignment: CS1, CS2

Module Structure

1: Loss Models

Claim frequency distributions, Claim severity distributions, Aggregate loss models, Compound distributions

2: Risk Classification

Risk classification principles, Rating variables, Credibility theory, Experience rating

3: Pricing Models

Pure premium method, Exposure rating, Generalised Linear Models in pricing, Pricing adjustments

4: Claims Reserving

Claims triangles, Chain ladder method, Bornhuetter-Ferguson method, Stochastic reserving models

5: Risk Measures

Value-at-Risk, Tail Value-at-Risk, Capital allocation, Solvency considerations

Primary Textbooks

- Klugman, S. A., Panjer, H. H., & Willmot, G. E. (2012). *Loss Models: From Data to Decisions* (4th ed.). Wiley.
- England, P. D., & Verrall, R. J. (2002). *Stochastic Claims Reserving in General Insurance*. British Actuarial Journal, Institute and Faculty of Actuaries.
- Mikosch, T. (2009). *Non-Life Insurance Mathematics: An Introduction with Stochastic Processes*. Springer.

Supplementary References

- Wu"thrich, M. V., & Merz, M. (2008). *Stochastic Claims Reserving Methods in Insurance*. Wiley.
- Denuit, M., Dhaene, J., Goovaerts, M., & Kaas, R. (2005). *Actuarial Theory for Dependent Risks: Measures, Orders and Models*. Wiley.
- Bu"hlmann, H., & Gisler, A. (2005). *A Course in Credibility Theory and Its Applications*. Springer.
- Kaas, R., Goovaerts, M., Dhaene, J., & Denuit, M. (2008). *Modern Actuarial Risk Theory*. Springer.

AE21 STOCHASTIC RISK MODELLING

Course Type: Core Elective

IFoA Alignment: CS2

Module Structure

1: Markov Chains

Discrete-time Markov chains, Transition matrices, Stationary distributions

Module 2: Poisson Processes

Counting processes, Homogeneous Poisson process, Non-homogeneous Poisson processes

Module 3: Continuous-Time Markov Processes

Transition intensities, Kolmogorov equations, Applications in insurance models

Module 4: Risk Processes

Collective risk model, Ruin probability, Lundberg inequality

Module 5: Simulation

Monte Carlo simulation, Random number generation, Simulation in actuarial risk modelling

Primary Textbooks

- Ross, S. M. (2014). *Introduction to Probability Models* (11th ed.). Academic Press.
- Rolski, T., Schmidli, H., Schmidt, V., & Teugels, J. (2009). *Stochastic Processes for Insurance and Finance*. Wiley.
- Asmussen, S., & Albrecher, H. (2010). *Ruin Probabilities* (2nd ed.). World Scientific.

Supplementary References

- Norris, J. R. (1997). *Markov Chains*. Cambridge University Press.
- Grimmett, G., & Stirzaker, D. (2001). *Probability and Random Processes* (3rd ed.). Oxford University Press.
- Mikosch, T. (2009). *Non-Life Insurance Mathematics: An Introduction with Stochastic Processes*. Springer.
- Glasserman, P. (2004). *Monte Carlo Methods in Financial Engineering*. Springer.

AE15 SURVIVAL MODELS

Course Type: Core

IFoA Alignment: CS2

Module Structure

1: Survival Modelling

Survival probabilities and lifetime models, Survival and hazard functions, Relationships between ${}_t p_x$ and ${}_t q_x$, Gompertz and Makeham mortality laws, Complete and curtate future lifetime, Two-state models of single decrement

R Exercises

- Simulating survival times under parametric mortality laws
- Plotting survival and hazard functions

2: Estimating Lifetime Distributions

Censoring mechanisms and life table data, Maximum likelihood estimation for lifetime models, Kaplan–Meier estimator, Nelson–Aalen estimator and cumulative hazard, Parametric survival estimation with censored data

R Exercises

- Kaplan–Meier survival estimation
- Estimation of cumulative hazard functions

3: Regression and Parametric Hazard Models

Parametric survival models, Cox proportional hazards regression, Time-dependent covariates, Partial likelihood estimation, Two-state Markov survival models, Poisson models and links with Markov processes

R Exercises

- Estimation of Cox models
- Diagnostic checks for proportional hazards models

4: Exposure-to-Risk and Mortality Data

Calculation of exposed-to-risk, Census approximations and data issues, Definitions of age and classification of deaths, Estimation of transition intensities, Consistency between population and mortality data

R Exercises

- Construction of mortality rates from exposure data
- Visualisation of mortality tables

5: Graduation and Mortality Projection

Statistical tests of mortality experience, Chi-square and deviation tests, Graduation methods (parametric, standard tables, splines), Comparison and testing of graduation methods, Mortality projection methods and forecasting errors

R Exercises

- Graduation of mortality rates using smoothing methods
- Basic mortality projections

Primary Textbooks

- Kleinbaum and Klein. *Survival Analysis: A Self Learning Text*
- Dickson, Hardy and Waters. *Actuarial Mathematics for Life Contingent Risks*
- Benjamin and Pollard. *The Analysis of Mortality and Other Actuarial Statistics*

IFoA CS2 Core Reading

AE39 REGULATION AND INSURANCE MARKETS

Course Type: Core

Module Structure

1: Insurance Markets

Role of insurance in financial systems, Insurance demand and supply, Market structure

2: Indian Insurance Market and Regulation

Evolution of the insurance sector in India, Liberalization and entry of private insurers
Role and functions of the Insurance Regulatory and Development Authority of India (IRDAI), Regulatory framework governing life and general insurance, Solvency requirements and regulatory oversight in India

3: Capital and Risk Management

Capital management in insurance companies, Risk-based capital models

- Concept of economic capital
- Regulatory capital requirements
- Capital adequacy and solvency margins
- Enterprise Risk Management (ERM)
 - Identification and measurement of insurance risks
 - Risk appetite and risk limits
 - Risk mitigation and diversification
- Own Risk and Solvency Assessment (ORSA)
 - ORSA framework and objectives
 - Integration with risk management and capital planning
 - Role of ORSA in regulatory supervision

4: Corporate Governance

- Principles of corporate governance in insurance companies
- Governance structure of insurers
 - Role of the Board of Directors
 - Key board committees: audit, risk and investment committees
- Role of actuaries in corporate governance
 - Responsibilities of the appointed actuary
 - Actuarial oversight of reserves and solvency
 - Reporting to regulators and management
- Risk governance frameworks
 - Enterprise risk management
 - Role of risk committees
 - Three-lines-of-defence model
- Professional ethics and regulatory governance requirements

5: Consumer Protection

Policyholder protection, Market conduct regulation, Financial stability considerations

Primary Textbooks

- Rejda, G. E., McNamara, M., & Rabel, W. (2017). *Principles of Risk Management and Insurance* (13th ed.). Pearson.
- Skipper, H. D., & Kwon, W. J. (2007). *Risk Management and Insurance: Perspectives in a Global Economy*. Blackwell Publishing.
- Harrington, S. E., & Niehaus, G. (2004). *Risk Management and Insurance* (2nd ed.). McGraw–Hill.

Supplementary References

- Cummins, J. D., & Weiss, M. A. (2014). *Systemic Risk and the U.S. Insurance Sector*. Journal of Risk and Insurance, American Risk and Insurance Association.
- Vaughan, E. J., & Vaughan, T. (2014). *Fundamentals of Risk and Insurance* (11th ed.). Wiley.
- IAIS (2019). *Insurance Core Principles and Common Framework for the Supervision of Internationally Active Insurance Groups*. International Association of Insurance Supervisors.
- IRDAI (various reports). *Annual Report of the Insurance Regulatory and Development Authority of India*. Insurance Regulatory and Development Authority of India.
- Palande, P., Shah, R., and Lunawat, M. *Insurance in India: Changing Policies and Emerging Opportunities*. Response Books.
- Government of India. *Report of the Malhotra Committee on Insurance Sector Reforms*. Ministry of Finance.