

CURRICULUM OF B.A. (Hons.) ECONOMICS

The under-graduate programme is designed to offer B.A. (Honours) degree in Economics. The Programme is organized on the semester pattern. The academic year consists of two semesters of about 16 weeks each. Each semester consists of 4-5 courses. The main features of the curriculum are as follows:

1. Core Courses (CC), which are compulsory
2. Ability Enhancement (AE) Courses are also compulsory. The AE courses are of two types: Ability Enhancement Compulsory Courses (AECC) and Skill Enhancement Courses (SEC):
 - a. AECC include English (Communication) and Environmental Studies/Science; and second language (a pass course).
 - b. SEC include a pool of courses designed to provide skill-based knowledge.
3. Elective Courses: Students can choose a pool of courses and which may be very specific or specialized or advanced or supportive to the discipline. Elective Courses are grouped as:
 - a. Generic Electives (GE): Electives from unrelated or allied subjects
 - b. Discipline Specific Electives (DE): Electives offered by the main discipline are DSEs (certain electives may be discipline-related or interdisciplinary in nature)
 - c. Dissertation/Project: This is optional. Helps acquire special/advanced knowledge in a particular field (substitute for one course under DE)
4. For successful completion of the Programme, the student must earn a total of 142 credits.

The distribution of credits across core and elective courses is shown in Table 1. Table 2 shows the distribution of courses across semesters. Finally, Table 3 shows the list of elective courses.

Table 1: Structure of B.A. (Honours) Programme

Course Type	Number of Courses	Number of Credits (Theory)	Number of Credits (Tutorial/Practical)	Total Credits
Core Course (CC)	14	5	1	84
Generic Elective (GE)	4	5	1	24
Discipline specific elective (DE)	4	5	1	24
Ability Enhancement Courses (AE: AECC+SEC)\$	4 (AECC-2 & SEC-2)	2*	0	10
Total	26	-	-	142

*Notes: *AE1 (English) course is given 4 credits. \$AE2 is the second language (pass) course, to be completed within first 4 semesters of the program. For this students need to register with UGC's Mooch (online) program or University of Madras Certificate Program to clear second language (German/French/or any Indian language including Tamil and Hindi).*

Table 2: Course Structure Across Semesters

Year	Odd Semester	Even Semester
Year 1	Principles of Microeconomics (CC1) Mathematical Methods for Economics I (CC2) Indian Economy (CC3) English (AE1)	Principles of Macroeconomics (CC4) Mathematical Methods for Economics II (CC5) Money and Banking (CC6) Environmental Studies/Science (AE2)
Year 2	Intermediate Microeconomics (CC7) Statistics for Economics (CC8) Decision Support System (AE3) GE1 DE1	Intermediate Macroeconomics (CC9) Introductory Econometrics (CC10) Introduction to R/Matlab/Python (AE4) GE2 DE2
Year 3	Public Economics (CC11) Development Economics (CC12) GE3 DE3	International Trade (CC13) Applied Econometrics (CC14) GE4 DE4/Dissertation

Note: The Second language (Tamil/Hindi/French/German etc.) is a pass course

Table 3: Elective Course

Type of Elective	Courses
Generic Elective (GE)	1. History of Western Philosophy 2. Logic and Philosophical Inquiry 3. Real Analysis 4. Abstract Algebra 5. Operations Research 6. Differential Equations 7. Stochastic Calculus 8. Introduction to Business Analytics 9. Introductions to Computer Programming 10. Introduction to Machine Learning 11. Introduction to Data Science 12. Introduction to Behavioural Economics 13. Probability Theory 14. Linear Algebra
Ability Enhancement: Compulsory Courses (AECC)	English Environmental Studies/Science
Ability Enhancement: Skill Enhancement Courses (SEC)	Decision Support System Introduction to R/Matlab/Python
Discipline Specific Electives (DSE)	1. Advanced Macroeconomics 2. Introduction to Game Theory 3. Issues in Development Economics 4. Risk Management 5. Energy Economics 6. Financial Economics 7. International Finance 8. Environmental Economics 9. Introduction to Time Series Analysis 10. History of Economic Thought 11. Economics of Climate Change and Development 12. Optimization in Economic Theory 13. Stochastic Process 14. Introduction to Non-Linear Time Series Econometrics 15. Project / Dissertation

CORE COURSES

SEMESTER I

CC:01 PRINCIPLES OF MICROECONOMICS

1: Consumer Theory

- Preference; utility; budget constraint; choice: utility maximization; demand; elasticity: price, income, cross price elasticity; indirect utility function; Slutsky equation; inferior, normal and Giffen goods; Roy's identity, revealed preference: weak axiom, compensated law of demand; consumer surplus, equivalent variation and compensating variation

2: Choice under Uncertainty and Intertemporal Choice

- Choice under uncertainty – utility function and expected utility, risk aversion and risk preference; intertemporal choice: savings and borrowing

3: Production and Costs

- Technology; isoquants; production with one and more variable inputs; returns to scale; Law of variable proportion, total, average and marginal product, marginal rate of technical substitution, iso-cost line and firm's equilibrium, elasticity of substitution; cost minimization; expansion path, short run and long run costs; various cost curves in the short run and long run and its relation; economies of scale; Shepard's lemma, Hotelling's lemma

4: Perfect Competition

- Review of perfect competition-firm and industry equilibrium, Marginal Revenue, Marginal Cost and Profit Maximization; uniqueness and stability of equilibrium, efficiency and welfare, tax incidence analysis, price-controls and shortages.

5: Input Market in a Competitive Setup

- Input demand for a competitive firm and competitive industry, Marginal productivity theory of distribution; Labour market-supply of labour, competitive labour markets, equilibrium, returns to scale and product exhaustion, Land markets and rent

Textbooks

- Varian, H. (2010). Intermediate microeconomics: A modern approach, 8th ed. W. W. Norton.
- Bernheim, B., Whinston, M. (2009). Microeconomics. Tata McGraw- Hill.
- Snyder, C., Nicholson, W. (2010). Fundamentals of Microeconomics. Cengage Learning.
- Robert Pindyck, Daniel Rubinfeld (2017): Microeconomics Eighth Edition, Pearson
- Bergstrom, T., Varian, H. (2014). Workouts in Intermediate Microeconomics. W. W. Norton.

CC:02 MATHEMATICAL METHODS FOR ECONOMICS I

1. Polynomial and rational functions. Quadratic equations, exponential and logarithmic functions, trigonometry and trigonometric functions. Coordinate geometry, circle, ellipse, hyperbola.
2. Complex numbers, fundamental theorem of algebra, mathematical induction, binomial theorem, series, and sequences, convergence.
3. Calculus of one variable; Limits, derivatives, chain rule, Taylor's series, maxima minima, integral calculus
4. Parametric equations and polar coordinates, Vectors, Matrices and Determinants.
5. Constrained and Unconstrained optimization, Lagrange Multiplier, Kuhn-Tucker condition, Envelope Theorem and Linear Programming.

Textbooks

- Rosen, Kenneth H. Discrete mathematics and its applications. 7th Ed. New York: McGraw-Hill, 2012.
- Simon, Carl P. and Blume L., Mathematics for Economists, Viva-Norton Student Edition, 2010.
- Stewart, James, Calculus Early Transcendentals, 6th Ed. Thomson Brooks/Cole, 2008.

CC: 03 INDIAN ECONOMY

1. Pros and cons of colonial rule and the status of Indian economy on the eve of Independence. The Soviet model of planning in India- Historical roots, evolution of plan models, limitation and lessons- Dominance of Public Sector and License Raj. Industrial Stagnation. Indian Economy in the 1980s-Nationalization of Banks- Industrial revival in the 1980s- Initial round of reforms in the 1980s- Growth revival in the late 1980s.
2. Importance of agriculture in national economy; Productivity in agriculture; Land reforms; New technology in Indian agriculture- Green Revolution- Need for second Green Revolution; Modern farm inputs and marketing- price policy and subsidies; Commercialisation and diversification
3. Poverty in India- Magnitude and determinants; Concepts of Poverty and Poverty Line- Trends and Pattern of Urban and Rural Poverty- Committees on poverty estimation; Poverty eradication programmes. Pattern of income distribution and the question of inequality in India.
4. Economic Crisis of early 1990s-Macro Economic Reforms since 1991-Structural Adjustment Programmes- Globalisation, Liberalisation and Privatisation- impact of 25 years of reforms on various sectors of the economy- Planning to markets - NITI Aayog and discontinuation of Central Planning- Demonetisation and its macro-economic impact - growth and inequality from regional perspective in Poverty in India.
5. Service sector as the engine of growth in India- Trade in services- Global technological change and Indian IT boom. Challenges of India's Service sector -External Sector- Foreign Trade- Salient features, composition and direction; Trade reforms- Balance of Payment; Exchange rate- India and WTO- Money and Banking- Organisation of India's money market and capital market- Changing role of Reserve Bank of India, Commercial banks, Development finance institutions, foreign banks and Non-banking financial institutions

Textbooks

1. Ahluwalia Isher Judge (1985): 'Industrial Growth in India: Stagnation Since the Mid-Sixties'. Oxford University Press, New Delhi.
2. Balakrishnan, P. (2010): 'Economic Growth in India: History and Prospect'. Oxford University Press, New Delhi.
3. Balakrishnan, P. (ed) (2011): 'Economic Reforms and Growth in India'. Orient Black Swan, Hyderabad.
4. Bhagwati Jagdish and Arvind Panagariya(2012): ' India's Tryst with Destiny'. Collins

Business, Noida, India.

5. Deaton, A. and V. Kozel (ed) (2005): 'The Great Indian Poverty Debate'. New Delhi: Macmillan.
6. Nayyar Deepak (1994): 'Industrial Growth and Stagnation: The Debate in India', Oxford University Press, New Delhi.
7. Kapila, Uma (2016): 'Indian Economy since Independence: A Comprehensive and Critical Analysis of India's Economy 1947-2016', Academic Foundation, New Delhi.
8. Eswaran Mukesh and Ahosk Kotwal (1994): 'Why Poverty Persists in India'. Oxford University Press, New Delhi.
9. Jalan B (2017): 'India: Priorities for the Future'. Penguin Random House, New Delhi.
10. Jean Dereze and Amartya Sen (1996): 'An Uncertain Glory: India and its Contradictions'. Penguin Books Ltd. London.
11. Jeffrey Sachs, Ashutosh Varshney and Nirupam Bajpai (eds).(1999): India in the Era of Economic Reforms, Oxford University Press, New Delhi.
12. Rakesh Mohan (ed) (2017): 'India Transformed- 25 years of Economic Reforms'. Penguin Random House, New Delhi.
13. Vijay Joshi (2016): 'India's Long Road: The Search for Prosperity'. Penguin Random House, New Delhi. Publishers, New Delhi.

SEMESTER II
CC:04 PRINCIPLES OF MACROECONOMICS

1. Time Series Decomposition, Schools of Economic Thought, National Income Accounts and Distribution of Income, Baumol-Tobin model of money demand, money supply determination and The Aggregate Supply curve in the Classical Model.
2. The Solow-Swan growth model, the Golden rule level of capital accumulation, speed of convergence, absolute versus conditional convergence, transitional dynamics & empirical evaluation of neoclassical growth models.
3. Linear & nonlinear ordinary differential equations (ODE), equilibrium points, stability of equilibrium points, phase diagram, method of undetermined coefficients, etc. We shall also see how nonlinear ODE can be transformed into linear ODE and examine linear approximation methods.
4. Introduction to Endogenous Growth, the AK growth model, the Lucas (1988) model of human capital, empirical evaluation of endogenous growth models, and the role of institutions (social infrastructure) in long-run economic growth.
5. The Great Depression, Irving Fisher's Debt Deflation Hypothesis, Keynesian Revolution, the IS-LM model of Aggregate Demand, the IS-LM-BP model of the Open Economy (Mundell-Fleming model), the Gold Standard and international transmission of shocks.

Textbooks

- Barro, Robert J. and Xavier Sala-i-Martin, Economic Growth, McGraw-Hill, 1995. (Advanced treatment)
- Blanchard, Olivier (2003), Macroeconomics, Prentice Hall, Third Edition.
- Chiang, A.C. (1984) Fundamental Methods of Mathematical Economics. 3rd Edition, McGraw-Hill, Singapore. (Mathematical background)
- Jones, Charles I., Introduction to Economic Growth, New York: W.W. Norton and Co., 1998. First Edition. (Main textbook)
- Mankiw, Gregory. N (2002), Macroeconomics, Worth Publishers; 5th edition. (Main textbook)
- Snowdon, B., Vane, H. and Wynarczyk, P. (1994), A Modern Guide to Macroeconomics: An Introduction to Competing Schools of Thought. Northampton MA: Edward Elgar Publishing.

CC: 05 MATHEMATICAL METHODS FOR ECONOMICS II

1. Vectors in 2- and 3-dimensional Euclidean spaces.
2. Partial derivatives, Taylor's Series, maxima minima in several variables, Multiple integrals.
3. Vector calculus. Theorems of Green, Gauss, and Stokes.
4. Linear Algebra, Matrix Factorization, Echelon Form, Row, Column and Null Spaces, Orthogonal Matrices.
5. Least Squares, SVD, Gradient, Hessian and Jacobian. Change of Basis, Eigen values and Eigenvectors.

Textbooks

- Lay, David C, McDonald, Judi J and Lay, Steven R. Linear Algebra and Its Applications, 5th Ed, Pearson, 2015.
- Simon, Carl P. and Blume L., Mathematics for Economists, Viva-Norton Student Edition, 2010
- Stewart, James, Calculus Early Transcendentals, 6th Ed. Thomson Brooks/Cole, 2008.

CC:06 MONEY AND BANKING

1: Financial System and Money: Overview of Financial system and introduction to money, role of money in the payment system, financial instruments and financial markets.

2: Interest Rates: Meaning of interest rates, types of interest rates, interest rates and asset values, present value, future value, risk and term structure of interest rates

3: Banks and NBFCs: Banking regulation act 1949 and revision/re-regulation, nationalized and private banks, non-banking financial intermediaries

4: Central Bank: Role of central banks, central bank balance sheet and money supply process, conduct of monetary policy, central bank and foreign exchange, Basel norms

5: Financial Market: Capital markets- primary and secondary, Introduction to the stock market, rational expectations, efficient market hypothesis

Textbooks

- Money, Banking, and Financial Markets, Fourth Edition, Stephen G. Cecchetti, Kermit L. Schoenholtz
- Money and Banking, Robert E. Wright, Vincenzo Quadrini

SEMESTER III

CC:07 INTERMEDIATE MICROECONOMICS

1: General Equilibrium, Efficiency and Welfare

- Equilibrium and efficiency under pure exchange and production; Walras law; Pareto Optimality, Edgeworth box and contract curve; efficiency and welfare economics: fundamental theorems of welfare economics.

2: Monopoly

- Monopoly and barriers to entry; pricing with market power; mark-up, Lerner's index; price discrimination: 1st degree, 2nd degree, 3rd degree; dead-weight loss; impact of tax

3: Monopolistic Competition

- Product differentiation, love for variety, Perceived and proportionate demand, short run and long run equilibrium, excess capacity, ideal output

4: Game theory and Oligopoly

- Normal and extensive form of games under complete information, Sequential and simultaneous games, dominant strategies and elimination of dominated strategies, Nash equilibrium, Dynamic games, backward induction, subgame perfect equilibrium, applications: Cournot model, Bertrand Model, Quantity and Price leadership

5: Market Failure

- 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; asymmetric information and moral hazard: principal agent problem, theory of lemon, credit market, implications of asymmetric information, market signalling, hidden information modelling

Textbooks

- Varian, H. (2010). Intermediate Microeconomics: A modern approach, 8th ed. W. W. Norton.
- Bernheim, B., Whinston, M. (2009). Microeconomics. Tata McGraw- Hill.
- Snyder, C., Nicholson, W. (2010). Fundamentals of Microeconomics. Cengage Learning.
- Robert Pindyck (Author), Daniel Rubinfeld (2017): Microeconomics Eighth Edition, Pearson
- Bergstrom, T., Varian, H. (2014). Workouts in Intermediate Microeconomics. W. W. Norton.
- Osborne, M. (2004). An introduction to game theory. Oxford University Press.

1: Probability Theory

- Sets, Sample spaces and events;
- probability axioms and properties; counting techniques;
- conditional probability and Bayes' rule; independence

2: Random Variables and Probability Distributions

- Defining random variables; discrete and continuous random variables, probability distributions – pdf and cdf; uniform, binomial, exponential, Poisson, hypergeometric and Normal random variables

3: Expectation

- Order Statistics and expected values and functions of random variables;
- Median, quantiles, variance,
- Covariance and conditional expectations

4: Random Sampling, Law of Large Numbers and Central Limit Theorem

- Sample and population, simple random sampling, estimators,
- Law of large numbers,
- Central Limit Theorem

5: Estimation Methods and Properties; Confidence Intervals and Hypothesis Testing

- Estimation of population parameters using methods of moments and maximum likelihood procedures; properties of estimators; bias, efficiency and consistency
- confidence intervals for population parameters, Defining statistical hypotheses; distributions of test statistics; testing hypotheses related to population parameters; Type I and Type II errors; power of a test; tests for comparing parameters from two samples

Textbooks

- Larsen, R., and M. Marx. Introduction to Mathematical Statistics and Its Applications. 4th ed. Upper Saddle River, NJ: Pearson Prentice Hall, 2005. ISBN: 9780131867932.
- Gupta S C and Kapoor V K - Fundamentals of Mathematical Statistics, Sultan Chand and Sons (2017).

SEMESTER IV

CC:09 INTERMEDIATE MACROECONOMICS

1. Inflation, Unemployment, and the Phillips Curve, the Natural Rate Hypothesis of Friedman and Phelps (1968), determinants of the natural rate of unemployment, Adaptive Expectations Hypothesis (AE), the Neoclassical-Keynesian Synthesis, stagflation of the 1970's and the breakdown of the Phillips curve.
2. Theories of consumption and investment. The consumption puzzle, Ando-Modigliani Life-cycle model, Friedman's permanent income hypothesis (PIH), and Hall's random walk hypothesis.
3. Endogenous technological change, models with an expanding variety of products (Romer, 1990) and Schumpeterian models of quality ladders (Aghion and Howitt, 1992), scale effects, externalities (knowledge-spillover and duplication problem), and empirical evaluation of idea-based growth models.
4. Rational Expectations Hypothesis (RE), solving linear RE models, basic method, Muth method of undetermined coefficients, MSV criteria, comparison of AE with RE when there is a policy regime change.
5. Policy Implication of Rational Expectations Hypothesis, Sargent-Wallace (1975) policy invariance result, cost of disinflation under AE and RE, and the rules versus discretion debate.

Textbooks

- Attfield, C., D. Demery and N. Duck (1992) Rational Expectations in Macroeconomics 2nd Edition, New York: Basil-Blackwell. (Basic introduction to AEH and REH)
- Blanchard, Olivier (2003), Macroeconomics, Prentice Hall, Third Edition.
- Chiang, A.C. (1984) Fundamental Methods of Mathematical Economics. 3rd Edition, McGraw-Hill, Singapore. (Mathematical background)
- Jones, Charles I., Introduction to Economic Growth, New York: W.W. Norton and Co., 1998. First Edition. (Main textbook)
- Mankiw, Gregory. N (2002), Macroeconomics, Worth Publishers; 5th edition. (Main textbook)
- Minford, P., and Peel, D. (2002) Advanced Macroeconomics: A Primer, Northampton, MA: Edward Elgar. (Solving linear RE models)
- Lucas, R.E. and T.J. Sargent (1981), Rational Expectations and Econometric Practice, Allen & Unwin, London. (Volume 1)

CC:10 INTRODUCTORY ECONOMETRICS

1: Nature and Scope of Econometrics

Distinction between Economic Model and Econometric model; Concept of stochastic relation, Role of random disturbance in econometric model; Types of data; Application of Econometrics in different branches of social science

2: Two-variable Linear Regression Model and Introduction to Multiple Regression Model The classical assumptions; Concepts of population regression function and sample regression function; Estimation of model by method of ordinary least squares, Limitations of SLRM, Economic interpretations of the estimated model; Multiple Linear Regression Model: Estimation of parameters; partial regression coefficients; Simple correlation, partial correlation and multiple correlation

3: Classical Linear Regression Model (Simple and Multiple Linear Regression)

Properties of the Least Squares Estimators (BLUE) in SLRM- Gauss-Markov theorem; Qualitative (dummy) independent variables – intercept dummy and slope dummy (only interpretation of the model); Specification Analysis: Omission of a relevant variable: Inclusion of irrelevant variables, Tests of specification errors; Forecasting - Ex-post forecast and Ex-ante forecast, forecast error (only for two variable model)

4: Statistical Inference in Linear Regression Model

Use of standard normal, chi2, t, and F statistics in linear regression model; Testing hypothesis: Single test (t test and chi2 test) Joint test (F test); Goodness of fit (in terms of R^2 , adjusted R^2 and F statistic), Analysis of Variance (ANOVA); Statistical significance and economic importance

5: Violations of Classical Assumptions

Multicollinearity - Consequences, Detection (Variance Inflationary Factor (VIF)) and Remedies; Heteroscedasticity - Consequences, Detection (Lagrange Multiplier test) and Remedies; Autocorrelation - Consequences, Detection (Durbin-Watson test) and Remedies

Textbooks

- G.S..Maddala, Introduction to Econometrics, 3rd edition, John Wiley & Sons Ltd (2005).
- Wooldridge, Jeffrey M. (2013), Introductory Econometrics – A Modern Approach, CENGAGElearning
- J. Johnston, Econometric Methods, 3rd Edition, McGraw-Hill/Irwin; 4th edition (1996)
- Jan Kmenta, Elements of Econometrics, Macmillan Publishing company (1991)
- D. Gujarati, Basic Econometrics, McGrawhill Higher Education (2003)
- Greene W.H.: Econometric Analysis, 4th edition, Pearson Education (2000)
- Christopher Dougherty, Introduction to Econometrics, Oxford University Press, 3rd edition, Indian edition, 2007.

SEMESTER V

CC:11 PUBLIC ECONOMICS

1: Normative Approach to Public Finance

Welfare Economics-Pure Exchange Economy and Economy with Production- The Fundamental Theorem of Welfare Economics; Choosing among Pareto Efficient Points

2: Market Failure and Public Goods

Types of market failure- Public goods-Samuelson's theory-Lindahl Model of Pareto Optimality- Free rider problem- Efficient provision of public goods-Externalities-Introduction to Public Choice

3: Principles of Taxation and Grant Theory

Benefit approach, Ability to Pay Principle-Progressive Taxation-Excess Burden-Direct vs. Indirect Taxes-Theory of Tax Incidence-Theory of Grant

4: Deficit Financing and Public Debt

Deficit financing-measures of deficit and their relation with public debt-causes and sources of public debt-consequences of high level debt-debt sustainability-solvency conditions-debt dynamics-relation between debt and growth-Ricardian view, Keynesian view and neo-classical view.

5: Indian Fiscal System

Constitutional Assignment of Tax powers and Expenditure Responsibilities to Union and States-Transfers mechanism-Trends in Central and States Receipts and Expenditures-Tax Reforms-Deficit and Public Debt- FRBM rules; Finance Commission- local body governments-public sector undertakings.

Textbooks

- Govinda Rao, M: Studies in Indian Public Finance, Oxford University Press (forthcoming)
- Harvey S. Rosen: Public Finance, Richard Irwin Inc., (1992).
- Hillman A.L.: Public Finance and Public Policy, Cambridge University Press (2003)
- Jha, R: Modern Theory of Public Finance, Wiley Eastern Ltd., (1987)
- Musgrave, R.A, and P.B.Musgrave: Public Finance in Theory and Practice, McGraw-Hill, New York, (1976)
- Srivastava, D.K : Issues in Indian Public Finance, New Century Publications (2005)

Web Resources

<https://prezi.com/nqadt5-xobnq/m2-analyse-the-effects-of-fiscal-and-monetary-policies-for-a/>
<https://economics.stanford.edu/courses/public-finance-and-taxation-ii>
http://www.andrew.cmu.edu/user/rs9f/pf04_9_12_04_vol_1.pdf
<http://ocw.mit.edu/courses/economics/14-471-public-economics-i-fall-2012/lecture-notes/>
http://obs.rc.fas.harvard.edu/chetty/public_economics_lectures.pdf

CC 12: DEVELOPMENT ECONOMICS

This course covers macro and micro development models and issues. Starting from an overview of institutional explanations of slow growth and underdevelopment, we discuss theories of market failure in credit and insurance markets, and how the lack of financial markets affects households and firms in developing countries. The Microfinance “revolution” is covered subsequently. Before people can trade, invest and be productive workers they need to have enough to eat, be free of disease and be sufficiently educated: we move on to problems of providing adequate nutrition, health services and education.

1. Introduction and overview

- Convergence, neoclassical theory, growth accounting
- Technology, and population
- Divergence, poverty traps (complementarities, Multiple Equilibria and the Big Bush)

2. Institutions

- Colonial origins (the role of history)
- Formal institutions (Property rights, Governance, Corruption)
- Informal institutions (contract enforcement through networks and social capital)

3. Financial markets

- Credit, savings and insurance markets in developing countries (market failure)
- Micro-credit

4. Human Development

- Nutrition, health
- Education

5. Foreign Aid

Textbooks

Acemoglu, D. and J.A. Robinson (2012) Why Nations Fail: The Origins of Power, Prosperity and Poverty. London: Profile.

Banerjee, AV and E Duflo (2011) Poor Economics: a radical rethinking of the way to fight global poverty. New York: Public Affairs

Beatriz Armendáriz , Jonathan Morduch ,The Economics of Microfinance, The MIT Press 2007

Philippe Aghion and Peter Howitt , The Economics of Growth , The MIT Press, 2009

Piketty, T (2014) Capital in the 21st Century. Cambridge MA: Cambridge University Press.

Ray, Debraj. Development Economics. Princeton, NJ: Princeton University Press, 1998.

Rodrik, D. (2008) *One Economics, Many Recipes: Globalization, Institutions, and Economic Growth*. Princeton University Press.

Sachs, J. (2005) *The End of Poverty: Economic Possibilities for Our Time*. London: Penguin.

Stiglitz, J. (2002) *Globalization and its Discontents*. London: Penguin.

Easterly, William. *The Elusive Quest for Growth: Economists' Adventures and Misadventures in the Tropics*. Cambridge, MA: MIT Press, 2002

Yunus, M. (1999) *Banker to the Poor: Micro-Lending and the Battle Against World Poverty*. Public Affairs
UN Millennium Project, Jeffrey D. Sachs, Director, *Investing in Development: A Practical Plan to Achieve the Millennium Development Goals*, January 2005 (<http://unmp.forumone.com/>)

SEMESTER VI

CC:13 INTERNATIONAL TRADE

1. Mercantilist doctrine of balance of trade - Adam Smith and absolute advantage theory of trade- Ricardo and comparative advantage, its limitations- production possibility curve – Community indifference curve- Gain from trade- Offer curve- Determination of international equilibrium price.
2. Different concepts of terms of trade- Factors affecting terms of trade. Heckscher Ohlin Model- Stolper-Samuelson Theorem- Rybczynski Theorem.
3. Definitions of factor abundance- relationship between factor prices and commodity prices- Factor price equalisation theorem- Factor intensity reversal- the Leontief Paradox.
4. Other alternative explanations of the basis of trade in terms of technological lead, domestic market size and product cycle approach– Linder’s hypothesis– Intra-industry trade.
5. The rationale of tariffs, quotas and subsidies– infant industry argument– tariffs and factor income distribution– tariffs, terms of trade and domestic prices– the optimum tariff rate – tariffs, subsidies and distortions in commodity and factor markets – effective rate of protection. Welfare implications of tariff.

Textbooks

- Feenstra. R., and Taylor, A. (2014). International Economics, 3rd ed. Worth Publishers.
- Bhagwati, J., A. Panagariya, and T. Srinivasan. Lectures on International Trade (2nd edition), MIT Press, 1998.
- Van Marrewijk, C., International Economics, Oxford University Press, 2007.
- Krugman, P., Obstfeld, M., Melitz, M. (2018). International Economics Theory and Policy, 11th ed. Pearson Education.
- Pugel, T. (2015). International Economics, 16th ed. McGraw-Hill.

1: The Linear Regression Model

- Estimation, specification, inference and diagnostic testing: estimation, Mis-specification, functional forms, model selection

2: Advanced Topics in Regression Analysis

- Non-linear regression models, measurement errors, Using IV to solve omitted-variables problems

3: Panel Data Models and Estimation Techniques

- Types of panel data, Panel data models and estimation techniques: pooled regression, fixed and random effects models

4: Limited Dependent Variables Models

- Logit and Probit models for binary responses, Tobit models for truncated data.

5: Time Series Regression

- Basic concepts of time series, seasonality, time trend, autoregressive models, distributed lag models

Textbooks

- Stock JH and Watson MW (2019) Introduction to Econometrics, 4th edition, Pearson.
- Wooldridge, Jeffrey M. Introductory Econometrics: A Modern Approach. 3rd ed. Mason, OH: Thomson/South-Western, 2006. ISBN: 9780324289787.
- Christopher F. Baum, (2006), An Introduction to Modern Econometrics Using Stata, Stata Press
- Maddala, G. S. (2002), Introduction to Econometrics, Macmillan Publishing Company

GENERIC ELECTIVE (GE) COURSES

GE:01 HISTORY OF WESTERN PHILOSOPHY

1. Plato: Ideal State Justice Education Plato's Communism
2. Aristotle: Origin of the State End of the State –Law and Justice – Aristotle on Revolution
3. Rousseau: Social Contract General Will Sovereignty
4. Hobbes: Social Contract Sovereignty Liberty – Rights
5. Karl Marx: Materialism Class war Socialist Revolution Final Goal of Communism

Textbooks

- Collinson, Diane: Fifty Major Philosophers, London: Croom Helm, 1987.
- Lechte, John: Fifty Key Contemporary Philosophers, London: Routledge, 1994.
- Price, Joan A: Philosophy through the Ages, Australia: Wadsworth 2000.
- Scruton, Roger: A Short History of Modern Philosophy, London: Routledge, 1995.
- Catlin, The Story, of the Political Philosophers, London. Whittlesey House, 1939
- Cocker Francis W., Recent Political Thought. London, D. Appleton Century Company, 1934.
- Cocker Francis W., Reading in Political' Philosophy, New York, Macmillan. 1938.
- Doyle, Phyllis, A History of Political Thought, London, Jonathan Cape, 1961.

1: Introduction to Philosophy

- The definition, meaning, scope and subject matter of philosophy- the main branches of philosophy- Philosophical attitudes, motives for doing philosophy- characteristics of philosophy- schools of philosophy.

2: Formal Logic

- Definition, meaning- units of arguments- terms, definition, proposition, inference—mediate and immediate inference. Dilemma and fallacies.

3: Symbolic Logic

- The transition to modern logic; constants and variables; truth tables, propositional and predicate logic.

4: Indian Systems of Logic

- Hindu, Buddhist, etc

5: Research Methodology

- General directions on writing the dissertation, thesis and steps in writing; research design, language and style; sectional arrangement, regulations on quotations, documenting sources, preparing bibliography.

Textbooks

- Copi, Irving and Cohen, Carl: Introduction to Logic, 13th edition, Pearson Education India, 2008.
- Bergmann, Merrie: The Logic Book, 3rd ed., New York: Mcgraw - Hill 1998.
- Davis, Thomas D., Philosophy: An Introduction, New York: Mcgraw - Hill, 1993.
- Gangopadhyay, Mrinal: Indian Logic in its sources, New Delhi: Munshiram Manoharlal Publishers, 1984.
- Hurley, Patrick: A Concise Introduction to Logic, Melbourne: Wadsworth, 2000.

GE:03 REAL ANALYSIS

1. Review of Set Theory, Basics of Logic, Proof Techniques, Induction, Proof by Contradiction, Constructive proofs, Contrapositive, Relations, Functions, Different types of Mappings, Cardinality of Sets, Rational and Irrational Numbers
2. Real Number System, Sequences and Series of Real Numbers, Increasing, Decreasing and Monotonic Sequences, Sub-sequences, Types of Convergence, Sup, Inf, Completeness, Cauchy Sequences, Limsup, Liminf
3. Open and Closed Sets, Balls, Limit Points, Different Types of Norms, Metric Spaces, Compact and Connected Sets, Heine Borel Theorem, Bolzano Weierstrass Theorem, Applications to Economics
4. Limits and Continuity of Functions, Epsilon Delta definition, Types of Discontinuity, Intermediate Value Theorem, Uniform Continuity, Differentiability, Integrable Functions, Interchange of Integration and Differentiation.
5. Sequences and Series of Functions, Uniform Convergence, Power Series

Textbooks

- Walter Rudin, Principles of Mathematical Analysis, International Series in Pure and Applied Mathematics, 3rd Edition, McGraw-Hill, 1976.
- Robert G. Bartle and Donald R. Sherbert, Introduction to Real Analysis, Wiley, 2011.

GE:04 ABSTRACT ALGEBRA

1. Review of Set Theory, Basics of Logic, Proof Techniques, Induction, Proof by Contradiction, Constructive proofs, Contrapositive, Relations, Functions, Different types of Mappings, Combinatorics, Number Theory
2. Groups, Subgroups, Isomorphic Binary Structures, Cyclic Groups, Groups of Permutations, Orbits, Cycles, Cosets, Homomorphisms
3. Cauchy's Theorem, Finite Abelian Groups, Sylow's Theorem, Symmetric Group, Factor Groups, Polya's Enumeration Theorem
4. Rings, Ideals, Homomorphisms, Quotient Rings, Rings of Polynomials, Ideals, Integral Domain, Field of Quotients, Fermat's and Euler Theorem's, Polynomials over the Rationals
5. Fields, Field Extensions, Roots of Polynomials, Finite Fields, Factorization of Polynomials over a Field, Finite Fields, Automorphisms of Fields, Splitting Fields, Galois Theory and applications

Textbooks

- John B. Fraleigh and Neal Brand, A first course in Abstract Algebra, 8th Edition, Pearson, 2020.
- P.M. Cohn, Basic Algebra, Groups, Rings and Fields, Springer, 2005.
 - Charles C. Pinter, A Book of Abstract Algebra, 2nd Edition, Dover, 2010.

GE:05 OPERATIONS RESEARCH

1. Operations Research Models, Solving the OR Model, Queuing and Simulation Models, Art of Modeling, More than Just Mathematics, Phases of an OR Study Modeling with Linear Programming- Introduction, Two-Variable LP Model, Graphical LP Solution, Computer Solution with Solver and AMPL, Linear Programming Applications. The Simplex Method and Sensitivity Analysis - LP model in Equation Form, Transition from Graphical to Algebraic Solution, The Simplex Method, Artificial Starting Solution, Special Cases in the Simplex Method, Sensitivity Analysis
2. Duality and Post-Optimal Analysis- Definition of the Dual Problem, Primal–Dual Relationships, Economic Interpretation of Duality, Additional Simplex Algorithms, Dual Simplex Algorithm, Post-Optimal Analysis Bounded-Variables Algorithm, Duality, Unboundedness and infeasibility, Parametric Linear Programming Transportation Model and Its Variants Definition of the Transportation Model, Nontraditional Transportation Models, The Transportation Algorithm - Determination of the Starting Solution, Northwest-corner method, Least-cost method, Vogel approximation method (VAM), Iterative Computations of the Transportation Algorithm, etc
3. Classical Optimization Theory Unconstrained Problems, Constrained Problems Constrained derivatives (Jacobian) method. Sensitivity analysis in the Jacobian method, Lagrangean method- Inequality Constraints—Karush–Kuhn–Tucker (KKT) Conditions, Sufficiency of the KKT conditions. Nonlinear Programming Algorithms Unconstrained Algorithms, Constrained Algorithms.
4. Markov Chains: Definition of a Markov Chain, Absolute and n-Step Transition Probabilities, Classification of the States in a Markov Chain, Steady-State Probabilities and Mean Return Times of Ergodic Chains, First Passage Time, Analysis of Absorbing States.
5. Simulation Modeling Monte Carlo Simulation, Types of Simulation.

Textbooks

- G.B. Dantzig, Linear Programming and Extensions, Princeton Landmarks in Mathematics, Princeton University Press, 1963.
- D. Bertsekas and J. Tsitsiklis Introduction to Linear Optimization, Athena Scientific, 1997.
- D. Bertsekas, Nonlinear Programming, Athena Scientific, 2nd Edition, 1999.
- R. Bellman, Dynamic Programming, Dover, 2003.
- F. Hillier and G. Lieberman, Introduction to Operations Research, McGraw Hill, 11th Edition, 2021.

GE:06 DIFFERENTIAL EQUATIONS

1. Ordinary differential equations, first-order systems with constant coefficients.
2. Fourier series, Linear second-order ordinary differential equations, Laplace and Fourier Transforms.
3. Special functions, series solutions of ordinary differential equations, partial differential equations.
4. Existence and uniqueness of solutions, autonomous systems, Sturm-Liouville Theory, Elliptic.
5. Parabolic and Hyperbolic partial differential equations, Green's function.

Textbooks

- George F. Simmons, Differential Equations with Applications and Historical Notes, 3rd Edition, Chapman and Hall, CRC Press, 2016.
- Morris W. Hirsch, Stephen Smale and Robert L. Devaney, Differential Equations, Dynamical Systems, and an introduction to Chaos, Elsevier, 2004.
- Walter A. Strauss, Partial Differential Equations: An Introduction, 2nd Edition, Wiley, 2007.

GE:07 STOCHASTIC CALCULUS

1. Convergence of Random Variables, Limit Theorems, Introduction to Stochastic Process, Sample Paths, Discrete Time Markov Chains (DTMC), Transition Matrices, Equilibrium Distribution, Gambler's Ruin problem, Recurrent and Transient States, Continuous Time Markov Chain (CTMC), Forward and Backward Kolmogorov equations
2. Poisson Processes, Counting Process, Stationary and Independent Increments Property, Inter-arrival and Waiting Time Distributions, Nonhomogeneous and Compound Poisson Process
3. Conditional Expectation, Filtrations, Martingales, Martingale Representation and Convergence Theorem, Stopping Times, Super and Sub Martingales, Brownian Motion as a limit of a Random Walk
4. Brownian Motion, Stationary and Independent Increments Property, Reflection Principle, Hitting Times, Brownian motion with Drift, Geometric Brownian Motion, Quadratic Variation of Brownian Motion.
5. Ito Processes, Ito's Lemma, Ito Integrals, Ito Isometry, Stochastic Differential Equations, applications to Derivative Pricing

Textbooks

- Howard M Taylor and Samuel Karlin, An introduction to Stochastic Modeling, Academic Press, 3rd Edition, 1998.
- Sheldon M Ross, Introduction to Probability Models, Academic Press, 10th Edition, 2010.
- Martin Baxter and Andrew Rennie, Financial Calculus: An Introduction to Derivative Pricing, Cambridge University, Press, 1st Edition, 1996.

GE:08 INTRODUCTION TO BUSINESS ANALYTICS

1: Metrics

- Introduction to metrics and measurements. Management processes, data collection, databases to support organizational metrics

2: Management Reporting

- Understanding business objectives, problems to be solved, new initiatives. Examining the data and preparing management reports to address these. Interpreting and presenting management reports. Graphical and cross tabs.

3: Human Resources

- Work with Human Resources (HR) data, develop and understand HR metrics, prepare reports and develop recommendations for improvement in organizational HR performance – productivity, absenteeism, etc.

4: Marketing And Sales

- Work with Marketing and Sales data, develop and understand Marketing and Sales metrics, management reporting and present plans and recommendations supported by data for exercises such as rationalization of product lines, profitability etc.

5: Vertical Industries

- Understand business drivers in specific industries and relation to outcomes, profits, growth sustainability. Students will choose an industry, discover data, and use the concepts of metrics and reporting to understand the key determinants of success of the chosen industry. Examples: credit cards, electric utilities, government.

Textbooks

- Exit Voice And Loyalty Albert O. Hirschman – PDF available.
- An Introduction To Statistical Learning
- Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirami.

GE:09 INTRODUCTION TO COMPUTER PROGRAMMING

1. Basic model of computation, Data types, operators and variables. Operators and operands; statements; branching, conditionals, and iteration
2. Notion of Algorithms, Principle of Mathematical Induction. Basics of functional programming, notion of types
3. Iterative versus recursive style. Correctness and efficiency issues in programming, time and space measures.
4. Basics of imperative style programming. Assertions and loop invariants.
5. Top down design and examples of step-wise refinement. Programming using structures, introduction to encapsulation and object oriented programming.

Textbooks

- Subhashis Banerjee, S. Arun-Kumar, D. Dubhashi: Introduction to Computer Science. Manuscript.
- Structure and Interpretation of Computer Programs by Harold Abelson and Gerald Sussman with Julie Sussman, MIT Press, 1985.
- How to solve it by Computer by R. J. Dromey, Prentice-Hall India EEE Series
- Guttag, John. *Introduction to Computation and Programming Using Python: With Application to Understanding Data Second Edition*. MIT Press, 2016. ISBN: 9780262529624

Most of the topics are taken from the two courses in the links below. This will help in Econometric Data Science a lot. Especially if the tool used is Python.

<https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-0001-introduction-to-computer-science-and-programming-in-python-fall-2016/syllabus/>

https://nptel.ac.in/content/syllabus_pdf/106104074.pdf

GE:10 INTRODUCTION TO MACHINE LEARNING

- 1. Search Problems:** Review of Propositional and Predicate Logic, Constraint Satisfaction, Heuristic Search, Motion Planning, Action Planning, Knowledge Representation, Discrete mathematics and Algorithmic thinking
- 2. Supervised and Unsupervised Learning:** Basic framework and concept of training, test and validation data, building machine learning models, Review of basic probability and statistics, data cleaning
- 3. Linear Regression:** Motivation, Probabilistic Model, Matrix Calculus, Maximum likelihood approach, Weighted Least Squares, Gradient descent algorithm
- 4. Classification:** Formulation of the classification problem, Confusion Matrix, Precision and Recall, Binary and Multiclass Logistic Regression, Naïve Bayes algorithm, Applications to text analytics
- 5. Clustering and Dimension Reduction:** Introduction to K-means Clustering, Elbow Heuristic for choosing number of clusters, Hierarchical Clustering, Principal Component Analysis, connection to Optimization

Textbooks

- Mitchell T, *Machine Learning*, McGraw Hill 1997
- Russel S. and Norvig P. *Artificial Intelligence: A Modern Approach*, 3rd Ed., Prentice Hall, 2010
- Bishop C.M., *Pattern Recognition and Machine Learning*, Springer, 2006

GE:11 INTRODUCTION TO DATA SCIENCE

1: Data

- Constituent elements of data. Information theory. Data structures - representing data – Rows, Columns and Tables. Identifying problems in data

2: Data Descriptors

- Understanding data through summary statistics. Graphical exploration. Distributions. Sampling. Correlations and Inference

3: Big Data

- Descriptions of large data sets. Construction of large data and wide datasets. Tidy Data.

4: String Manipulation

- Dealing with textual data. Webscraping to harvest data. Cleaning, storing and organizing text data for analysis.

5: CRISP – DM

- Follow the cross industry standard process for data mining in a class project. Steps include: Business understanding, Data Understanding, Data Preparation, Modeling, Evaluation and Deployment.

Required Course Material

Python Programming Resources – setting up the environment

Tableau – install on desktops Supplemental Course Material

<http://www.datasciencecentral.com/>

<http://datasciencemasters.org/>

(Open Courseware and MOOCs)

https://en.wikibooks.org/wiki/Data_Science:_An_Introductio

<http://bhcc.onthehub.com/>

Blogs And Other Data Science Resources

<http://flowingdata.com>

<http://fivethirtheight.com>

<http://www.kdnuggets.com>

<https://www.kaggle.com>

GE 12: INTRODUCTION TO BEHAVIORAL ECONOMICS

The study of Economics relates to any aspect of human behavior involving the allocation of scarce resources. The key implication of scarcity is that individuals need to make decisions about what to do with their limited resources. In general, Economics assumes rational decision making, meaning that individuals choose the allocation of resources which maximizes their well-being. However, individuals do not always behave rationally. This course provides an introduction to Behavioral Economics, the study of how individuals make decisions based on more realistic psychological foundations.

1. Introduction and Foundations of Behavioral Economics

- i. Psychology and decision making
- ii. Heuristics and Biases in Decision Making

2. Risk Preferences

- i. The standard model
- ii. Prospect theory

3. Preferences

- i. The standard model
- ii. Hyperbolic discounting
- iii. Self-control and Procrastination

4. Social Preferences

- i. Altruism
- ii. Fairness
- iii. Reciprocity

5. Extensions

- i. Evolution and Culture
- ii. Neuroeconomics
- iii. Welfare and Policy

Textbooks

Edward Cartwright, 2011, Behavioral Economics, 2nd Edition, Routledge Advanced Texts in Economics and Finance, Taylor and Francis.

Michelle Baddeley, 2017, Behavioural Economics: A Very Short Introduction, Oxford University Press, Oxford, UK.

An Introduction to Behavioural Economics by Nick Wilkinson and Matthew Klaes, (2012), Palgrave MacMillan.
Animal Spirits by George Akerlof and Robert Shiller, (2009), Princeton University Press.

GE 13: PROBABILITY THEORY

1. Probability

Basic concepts in the field of probability: event, sample space, counting, combinatorics, conditional probability and independence, Bayes' theorem, base rate fallacy

2. Random variables

Random variable and cumulative distribution function, density function, Discrete and continuous, Expectations and Variance, Moments, moment generating functions, characteristic functions, quantiles

3. Special parametric families of univariate distributions

Discrete: Discrete Uniform distribution, Bernoulli distribution, Binomial distribution, Poisson, geometric and hyper-geometric uniform, negative binomial, Continuous: Uniform, Normal, Exponential, Gamma, Beta

4. Joint and conditional distributions

Joint, marginal and conditional distribution, Expectation, covariance, correlation, conditional Expectations, stochastic independence, Bivariate Normal distributions

5. Functions of Random variables and limit theorems

Method of Distribution function, Transformation Method, Law of Large numbers, Central Limit theorem, interpretations of probability / philosophy of probability, and Chebyshev's & Markov's inequalities.

Textbooks

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.

RA Johnson, "Miller and Freund's Probability and Statistics for Engineers", 2011. (Any edition will do.)

JL Devore, "Probability and Statistics for Engineering and the Sciences", 2010. (Any edition will do.)

GE 14: LINEAR ALGEBRA

Unit 1- Matrices. Geometry of Linear equations, elementary matrices, invertible matrices, transpose, Gaussian elimination, determinants, Cramer's rule, some special matrices and applications.

Unit 2 - Vector spaces. Vector spaces and subspaces over $\mathbb{R}$ and $\mathbb{C}$, Linear independence, Basis, Dimension, Linear transformations, Rank Nullity theorem, some fundamental subspaces, matrix of a linear transformation, dual space and linear functionals.

Applications - Graphs, networks and incidence matrices.

Unit 3 - Orthogonality. Perpendicular vectors, orthogonal subspaces, inner product spaces, orthogonal matrices, Gram-Schmidt orthogonalization, least squares approximations.

Applications - Introduction to infinite dimensional linear algebra, Fourier series and Fast Fourier transform.

Unit 4 - Diagonalization. Eigen values, Eigen vectors, Diagonalization, minimal polynomial, characteristic polynomial, Cayley Hamilton theorem, Symmetric, Hermitian, orthogonal, unitary operators, Similar matrices, Jordan form.

Applications - Difference and differential equations.

Unit 5 - Some extra topics and applications. Definiteness of matrices and optimization, Singular value decomposition, positive matrices, Introduction to Markov process, Linear programming, game theory.

Recommended books.

- (1) Linear algebra and its applications, Gilbert Strang, Cengage India, Fourth edition.
- (2) Introduction to Linear algebra, Gilbert Strang, Wellesley Cambridge Press, Sixth edition.
- (3) Linear Algebra done Right, Sheldon Axler, Springer Nature, Third edition.
- (4) Linear Algebra, K. Hoffman and R. Kunze, Prentice Hall India, Second edition.

ABILITY ENHANCEMENT (AE) COURSES

AE:01 ENGLISH

1: POETRY

- John Milton On His Blindness
- William Wordsworth Daffodils
- Percy Bysshe Shelley O z y m a n d i a s
- Emily Dickinson Because I could not stop for Death
- Sarojini Naidu the Queen's Rival

2: PROSE

- Francis Bacon of Love
- Charles Lamb a Dissertation upon Roast Pig
- Katherine Mansfield a Doll's House
- R. K Narayan an Astrologer's Day
- Abdul Kalam the Power of Prayer

3: DRAMA

- Oscar Wilde *Lady Windermere's Fan*

4: GRAMMAR

- Tenses
- Subject-Verb Agreement

5: COMPOSITION

- Essay Writing

Recommended Reading:

- Wisdom and Experience: An Anthology for Degree Classes. Board of Editors, Orient Longman Limited, 2007.
- Lalitha Natarajan and Sasikala Natesan: English for Excellence: Poetry Anuradha Publications
- Literary Pursuits: Board of Editors, Orient Longman Limited, 2015
- Literary Pinnacles: An Anthology of Prose and Poetry. Board of Editors, Orient Longman Limited, 2015.
- Brookside Musings: A Selection of Poems and Short Stories: Board of Editors, Orient Longman Limited, 2009.
- The Approach to Life: A Selection of English Prose: Orient Longman Limited, 2009.

E-Learning Resources:

John Milton: On His Blindness - <https://www.bartleby.com/4/313.html>
Sarojini Naidu: The Queen's Rival - <https://www.poemhunter.com/poem/the-queen-s-rival/>
Charles Lamb: A Dissertation upon a Roast Pig -<https://www.bartleby.com/380/prose/491.html>
Narayan: An Astrologer's Day -
[https://www.scribd.com/document/375116249/An-Astrologer-s Day pdf](https://www.scribd.com/document/375116249/An-Astrologer-s-Day-pdf)
Lady Windermere's Fan-
<https://www.gutenberg.org/files/790/790-h/790-h.htm>

AE:02 ENVIRONMENTAL STUDIES

1. Ecosystem: Ecosystem – Types and Functions; Linkage between Economy and Ecosystem; Degradation of Ecosystem; Need for Conservation of Ecosystems; Present state of Eco-systems with special reference to India.

2. Natural Resources: Resource Classification; Renewable and Non- Renewable Natural resources: Forest Resources, Water resources, Mineral resources, Land resources, Energy resources; Common Property resources (CPRs); Destruction of CPRs and its Impact on Human Welfare; Scarcity of Natural Resources; Concept and Management.

3. Environmental Pollution: Concept and Classification; Types of Environmental Pollution: Air Pollution, Water Pollution, Soil Pollution, Marine Pollution, Noise Pollution, Nuclear Pollution, Thermal Pollution; Causes of Pollution and Measures of Pollution Control.

4. Environmentalism: Introduction to Environmental thought; Environmentalism- Definition, Major Environmental Ideology; Evolution of Environmentalism; Current State of Environment: Biodiversity, Forest, Water, Air.

5. Environmental Regulations: Environmental Dimension of Sustainable Development Goals; Environmental Legislations and Policies in India; Environmental Justice and Ethics; Major International Environmental Negotiation/Agreement; Global/Regional Environmental Organization

Textbooks

1. J. E. De Steiquer, The origins of Modern Environmental thoughts. University of Arizona Press, 2006
2. Bhattacharya, K.S. and A. Sharma, Comprehensive Environmental Studies. Narosa Publishing House Private Ltd., New Delhi. 2015.
3. E. Bharucha, Textbook of Environmental Studies for Undergraduate Courses, UGC, New Delhi, 2004.
4. Hanley, N., Shorgren, J.F. and B. White, Introduction to Environmental Economics, Oxford University Press, 2019.

AE:03 DECISION SUPPORT SYSTEM (EXCEL SKILLS)

1. Look up tables, Index and matching, retrieval of selective data from the data base
2. Sensitivity, scenario and simulation analysis, Forecasting techniques - MAPE, Regression analysis
3. Optimisation technique
4. Graph
5. Time value of Money

Textbook

- Management Information System by James O'Brien

AE:04 INTRODUCTION TO R/MATLAB/PYTHON

1 : Basics and Flow Control

Computation Problem Solving-Limits of Computational Problem Solving - Computer Algorithm - Computer Hardware - Digital Computer - Operating System- Limits of IC technology - Computer Software - Syntax, semantics and program translation, Introduction to Python Programming Language, IDLE Python Development Environment, Output function - variables, types and id, input function, operators and expressions, Control structures.

2 : Collections & Basics of Functions

MATLAB windows, a first program, Expressions, Constants, Variables and assignment statement, Arrays, Lists, Tuples, Dictionaries, Sets, Strings and text file manipulation: reading and writing files. Functions: Definition, call.

3 : Functions and Graphical User Interface

Positional and keyword parameter, Default parameters, Variable number of arguments, Recursion, Callbacks, Closure, Decorators. Graphical User Interface with Tinker package- Different geometric methods – Tk, main loop, creating simple GUI - buttons, canvas, check button, labels, entry fields, dialogs Widgets - sizes, fonts, colors layouts, nested frames.

4 : Functional Programming, Modules, Testing and Debugging

Map, filter, reduce, max, min. lambda function - list comprehension, Modules - import mechanisms, Testing - Pytest, Function testing with Doctest, pdb debugger commands.

5 : Object Oriented Programming

Classes and objects - inheritance, polymorphism. Error handling & Exceptions - try, except and raise, exception propagation.

Textbooks:

- “MATLAB: An Introduction with Applications” Amos Gilat, 2nd Edition, Wiley, 2004
- “Numerical Computing with MATLAB”, C.B. Moler, SIAM, 2004.
- “Introduction to Computer Science Using Python: A Computational Problem-Solving Focus” Charles Dierbach, Wiley India Edition, John Wiley, 2015.

Reference Books:

- “Learn python Programming”, Fabrizio Romano, 2nd Edition, Packt Publishing, 2018.
- “Fundamentals of Python: First Programs”, Kenneth A. Lambert, Cengage, 2019.
- “Introduction to Computation and Programming Using Python: With Application to Understanding Data”, John V. Guttag, MIT Press, MIT with Library of Congress Cataloging-in- Publication Data, 2016.

DISCIPLINE SPECIFIC ELECTIVE (DSE) COURSES

DE:01 ADVANCED MACROECONOMICS

- 1 Lucas (1972, 1973) signal extraction model (the new classical Phillips curve), predictions of the signal extraction Phillips curve, rational expectations with future variables (REFV), bubbles, non-uniqueness problem and transversality condition.
2. Neutrality of fiscal feedback rules under RE, role for automatic stabilizers, asymmetric information and role for counter-cyclical stabilization under RE, Fischer (1977) overlapping wage contracts model, wage indexation, and the Lucas (1976) critique of policy evaluation.
3. The New Keynesian Phillips curve (NKPC), small menu costs and large business cycles (Mankiw, 1985), the Blanchard-Kiyotaki (1987) model of imperfect competition, the Calvo-Rotemberg model of staggered price adjustment, and predictions of the NKPC.
4. The case for Keynesian stabilization under RE, optimal policy and time inconsistency (Kydland and Prescott, 1977), inflation bias that results under discretion (Barro and Gordon, 1983).
5. Institutional structure, independence and fiscal-monetary coordination, Rogoff (1985) weight-conservative central bank, Inflation Forecast Targeting (Svensson, 1997), government solvency and constraints on fiscal policy, the unpleasant monetarist arithmetic, the Barro-Ricardo Equivalence result, debt dynamics, and OLG models to understand the role for government debt in general equilibrium.

Textbooks

Blanchard, Olivier (2003), *Macroeconomics*, Prentice Hall, Third Edition.

Chiang, A.C. (1984) *Fundamental Methods of Mathematical Economics*. 3rd Edition, McGraw-Hill, Singapore. (Mathematical background)

Minford, P., and Peel, D. (2002) *Advanced Macroeconomics: A Primer*, Northampton, MA: Edward Elgar. (Solving linear RE models)

Romer, D. (1996), *Advanced Macroeconomics*, First Edition, McGraw-Hill. (several chapters)

Walsh, Carl E. (2003), *Monetary Theory and Policy*, 2nd ed, The MIT Press. (several chapters)

DE:02 INTRODUCTION TO GAME THEORY

1: Simultaneous Move Games with Complete Information

- The normal form; solution concept: Iterated deletion of strictly and weakly dominated strategies; Best Response Functions and Nash equilibrium, mixed and pure strategies; applications

2: Extensive Form Games with Perfect Information

- The game tree; strategies; subgame perfection; backward induction; commitment; bargaining; other applications

3: Simultaneous Move Games with Incomplete Information

- Strategies; Bayesian Nash equilibrium; applications

4: Extensive Form Games with Imperfect Information

- Strategies; beliefs and sequential equilibrium; applications

5: Introduction to Mechanism Design and Auction

- introduction to mechanism design; objective and examples; Definition and examples; various types of auctions;

Textbooks

- Osborne, M. (2004). An introduction to game theory. Oxford University Press.
- 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.

DE:03 ISSUES IN DEVELOPMENT ECONOMICS

1: Demography and Development

- Demographic concepts; birth and death rates, age structure, fertility and mortality
- Demographic transitions during the process of development; gender bias in preferences and outcomes and evidence on unequal treatment within households
- Connections between income, mortality, fertility choices and human capital accumulation
- Migration

2: Land, Labor and Credit Markets

- The distribution of land ownership; land reform and its effects on productivity
- Contractual relationships between tenants and landlords
- Land acquisition; nutrition and labor productivity
- Informational problems and credit contracts
- Microfinance
- Inter- linkages between rural factor markets.

3: Individuals, Communities and Collective Outcomes

- Individual behaviour in social environments
- Multiple social equilibria
- Governance in organizations and in communities;
- Individual responses to organizational inefficiency.

4: Environment and Sustainable Development

- Defining sustainability for renewable resources
- A brief history of environmental change;
- Common-pool resources;
- Environmental externalities and state regulation of the environment;
- Market based instruments, economic activity and climate change.

5: Globalization

- Globalization in historical perspective
- Economics and politics of multilateral agreements;
- Trade, production patterns and world inequality
- Financial instability in a globalized world.
- India in the context of global economy

Textbooks

- Debraj Ray, Development Economics, Oxford University Press, 2009.
- ParthaDasgupta, Economics, a Very Short Introduction, Oxford University Press, 2007
- Abhijit Banerjee, Roland Benabou and Dilip Mookerjee, Understanding Poverty, Oxford University Press, 2006.
- Thomas Schelling, Micromotives and Macrobehavior, W. W. Norton, 1978.
- Albert O. Hirschman, Exit, Voice and Loyalty: Responses to Decline in Firms, Organizations and States, Harvard University Press, 1970.
- Raghuram Rajan, Fault Lines: How Hidden Fractures Still Threaten the World Economy, 2010.
- Elinor Ostrom, Governing the Commons: The Evolution of Institutions for Collective Action, CambridgeUniversity Press, 1990.
- Dani Rodrik, The Globalization Paradox: Why Global Markets, States and Democracy Can't Coexist, Oxford University Press, 2011.
- Michael D. Bordo, Alan M. Taylor and Jeffrey G. Williamson (ed.), Globalization in Historical Perspective, University of Chicago Press, 2003
- Nordhaus, W. (2013). The Climate Casino. Yale University Press.

DE:04 RISK MANAGEMENT

1: Principles of Risk Management

- Risk Management Process: Identify sources, risk assessment
- Efficient risk bearing; Risk intermediation
- Risk management through hedging, insuring and diversifying

2: Risk Measurement

- Distributions, standard deviation, VaR, CVaR
- Techniques of measurement - simulation, stress testing

3: Risk Management in Financial Institutions

- Banking business lines and regulations - market, credit and operational risks
- Capital adequacy and the Basel accords
- Managing market risks: Hedging, Duration, Asset-Liability Management
- Managing credit risks: 5Cs of credit, credit scoring, ratings, credit default swaps, credit VaR, CVA / XVA
- Managing operational, legal and tax risks
- Managing strategic risks and uncertainties

4: Risk Based Capital Allocation

- Risk adjusted valuation and returns
- Capital allocation using RAROC

5: Systemic Risk Management

- Financial networks - Cascades, systemic risk and TBTF
- 2008 crisis, response and macro-prudential regulation

Textbooks

- Financial Economics 2/e, Bodie, Merton and Cleeton
- Introduction to Derivatives and Risk Management, 10/e, Chance and Brooks
- Risk Management in Banking (2/e), Bessis
- Jorion, P. Financial Risk Manager Handbook, Wiley, 2002.

Suggested Cases:

- Banc One Corp.: Asset and Liability Management - Tufano/Esty (HBSP)
- JPMorgan and the London Whale - Chen/Zeisberger (HBSP)
- Deutsche Bank and the Road to Basel III - Allayannis; Yemen; Wicks; Dougherty (HBSP).

1: Energy and Economy

- Energy as resource; Classification, measurement and accounting; understanding energy-economy linkages

2: Energy Demand

- Short Run and Long Run Price and Income Elasticities; Energy demand at aggregate and disaggregated levels; Demand Side Management, policies and behavioural issues

3: Energy Supply – Non-renewable & Renewable Sources

- Economics and policies of non-renewable energy supply; Economics of electricity supply; Renewable energy and related policies

4: Energy Security

- Energy poverty – conceptual and measurement issues; Geo-political issues concerning energy supply

5: Energy and Environment

- Energy-environment interactions; Energy and climate change; Taxes and cap-and-trade mechanisms for internalization of environmental externalities; energy efficiency policies

Textbooks

- Schwarz, P. (2018), Energy Economics, Routledge.
- Bhattacharyya, Subhes. C. (2011), Energy Economics: Concepts, Issues, Markets and Governance, Springer.

1: Finance and Accounting

- Understanding transactions, Cash flow Statement, Balance Sheet, Assets and Liabilities, Profit and Loss statements, Indian accounting standards, Financial Ratios

2: Valuation

- Present and Future Values, Annuity, Perpetuity, Net Present Value; Valuation of Fixed income securities - Valuing bonds, term structure of interest rates, yield curves, spot and forward rates; Valuation of Stocks- Dividend discount model; Free cash flow model; Capital Budgeting techniques - payback period, internal rate of return

3: Risk and Returns

- Introduction to uncertainty, Expected utility, Risk Preferences, Risk Aversion, Mean-variance theory, Portfolio return and risk, Diversification and Hedging, Measures of risk aversion - absolute and relative risk aversions, Arrow-Pratt measures, the Markowitz model of optimal portfolio

4: Market Efficiency

- Efficient Market Hypothesis; Weak form, Semi-strong and Strong Form; Empirical evidence and Implications

5: Asset Pricing

- Systematic and specific risk, Capital market line, Capital asset pricing model (CAPM), Beta of an asset and portfolio, Security market line; Arbitrage Pricing Theory (APT)

Textbooks

- Brealey, R. and S. Myers, Principles of Corporate Finance, New York, MGH
- Copeland, T. E. and J. F. Weston, Financial Theory and Corporate Policy, Addison Wesley
- Damodaran, A., “Investment Valuation: Tools and Techniques for Determining the Value of Any Asset”, John Wiley & Sons
- Le Roy, S. F., and Werner, J. Principles of Financial Economics, CUP
- Elton, E.J and M.J. Gruber, Modern Portfolio Theory & Investment Analysis, John Wiley & Sons.

1: The Balance of Payments and Foreign Exchange Market

- Balance of payment accounts Foreign exchange market, Demand & supply of foreign exchange, Effects of exchange rate changes on domestic prices and terms of trade, Marshall-Lerner condition, J-curve effect

2: Theories of Exchange Rates

- Parity conditions, -Purchasing power parity and interest rate parity, The monetary theory of exchange rates, Sticky price models- theories of overshooting, Portfolio-balance approach to exchanges rates, Currency substitution.

3: Exchange Rates Models with Uncertainty

- Market efficiency and rational expectations, The ‘news’ model and exchange rate volatility, Models of risk premium

4: International Capital Flows and Financial Crises

- Financial crises, varieties, definitions. Models of currency and financial crisis. Crisis in emerging countries

5: Institutional Structure of International Finance

- History of exchange rate regimes (Classical gold-standard system, Bretton woods, Post Bretton woods era) Different Exchange Rate Regimes, Monetary unions, Role and functions of International Monetary Fund

Textbooks

- Krugman, Paul R., Maurice Obstfeld and Marc J. Melitz, International Economics: Theory & Policy, 9th edition, Addison-Wesley, 2012.
- Copeland, Laurence S. Exchange Rates and International Finance, 4th edition Pearson Education Limited, 2005.

1: Introduction

- Economy-Environment interaction; Environmental Kuznet's Curve hypothesis – theory and empirical evidence; Sustainable Development – weak and strong sustainability criteria; System of Environmental-Economic Accounting

2: Externalities and Public Goods

- Market Failure; Characteristics of public goods; Externalities; Pigouvian and Coasian solutions; Property rights; Collective action

3: Environmental Policy

- Command and control policy; Market based instruments – pollution taxes, tradeable permits, subsidies; Choice of policy instruments – price vs. quantity instruments

4: Environmental Valuation

- Concept of value; Relevance of environmental valuation; Methods of environmental valuation - Physical linkage methods, Abatement cost methods, Behavior linkage methods – Revealed and Stated preference; Benefit transfer

5: International Environmental Issues

- Transboundary pollution; Causes and consequences of ozone depletion and climate change; Protocols relating to climate change, Ozone depletion and biodiversity

Textbooks

- B. C. Field and M. K. Field (2020), *Environmental Economics: An Introduction*, (8th edition), McGraw-Hill.
- Kolstad, C. (2012), *Intermediate Environmental Economics*, (2nd Edition), Oxford University Press.

DE:09 INTRODUCTION TO TIME SERIES ANALYSIS

1: Univariate Time-Series Models

- Introduction to stationary processes, auto covariance functions, autocorrelation and partial autocorrelation, autoregressive and moving average models.

2: Box-Jenkins Approach

- Conditions for stationary and invertible process, Box-Jenkins approach, forecasting.

3: Multivariate and Multiple Equation Models

- Motivation for multivariate model, Autoregressive Distributive Lag Models, Simultaneity and 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.

4: 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.

5: Cointegration and ECM

- 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.

Textbooks

- Shumway & Stoffer, Time Series Analysis and its applications, with examples in R, Springer.
- Brockwell & Davis, Introduction to Time Series and Forecasting, Springer.
- Walter Enders, Applied Econometric Time Series, Wiley.
- Prado & West, Time Series: Modeling, Computation, and Inference Chapman & Hall

DE:10 HISTORY OF ECONOMIC THOUGHT

1. Introduction, the rise of capitalism and the methodology of economics. The Mercantilists and the Physiocrats.
2. The Classical School: Adam Smith, Thomas Robert Malthus and David Ricardo
3. Karl Marx and Marxian economics
4. Thorstein Veblen and the institutional economics; Theories of imperialism: Hobson, Lenin, etc
5. The Keynesian Revolution and Post-Keynesians; Heterodox Economics and Its Future

Textbooks

- The Worldly Philosophers by Robert L. Heilbroner, Simon and Schuster, New York, NY, 1999, ISBN 978-0684862149.
- E. K. Hunt and Mark Lautzenheiser, 2011. History of Economic Thought: A Critical Perspective. New York: M. E. Sharpe, Inc.
- Ken Cole. 1995. Understanding Economics. London: Pluto Press.
- William J. Barber. 1985. A History of Economic Thought. Middlesex: Penguin Books.
- Daniel R. Fusfeld. 2002. The Age of the Economist. Boston: Pearson Education.
- E. Ray Canterbury. 2002. A Brief History of Economics. New Jersey: World Scientific Publishing.

DE 11: ECONOMICS OF CLIMATE CHANGE AND DEVELOPMENT

Climate change has become inevitable in the 21st century and hence gaining knowledge, it's risk screening and understanding the economics of climate change and its impact on development is important.

1. Climate Change as a science:

Global warming and its adverse effects;

Tipping points;

Carbon emissions scenarios

2. Climate and development:

Social cost of carbon;

Climate change and Sustainable development;

Natural disasters and Sustainable development;

Poverty traps

3. Macroeconomics of Climate Change:

Climate Actions and Policy instruments, mainly the measures that are taken or can be taken for a low-carbon transition economy and emission reduction;

International environmental agreements

4. Impacts and Valuation:

Economic impacts;

Marginal economic impacts;

Purpose of valuation;

Valuation methods

5. Climate Change Mitigation and Adaptation:

Adaptation versus Mitigation;

Inclusive growth;

Optimal climate policy;

Discounting

Textbooks

Tol, R. S. (2023). Climate economics: economic analysis of climate, climate change and climate policy. Edward Elgar Publishing.

Nordhaus, W. (2013). The climate casino: Risk, uncertainty, and economics for a warming world. Yale University Press.

Various Intergovernmental Panel on Climate Change (IPCC) reports, World Bank reports, International Monetary Fund (IMF) reports and research papers

DE 12: OPTIMIZATION IN ECONOMIC THEORY

1. Linear Programming (LP)

Geometry of Linear Algebra, concept of an Objective function and constraints, formulation of LP, graphical solution, Simplex algorithm, Pivoting, Basic and Non-basic variables, Primal LP.

2. Dual LP

Concept of Duality, Formulation of dual LP, Duality theorems, Complementary slackness, Sensitivity analysis, Matrix representation of LP, Network flow and Graph problems, Interior point algorithms.

3. Integer Programming (IP)

Introduction to Hard Problems, Complexity of IP, Cutting Plane methods, Branch and bound algorithms, Unimodular matrices.

4. Nonlinear Optimization

Newton's method, Line searches, Gradient descent, Conjugate gradient method, Quadratic Programming, Lagrangean methods, KKT conditions, Convex sets and functions, different algorithms and their applications.

5. Dynamic Programming

Discrete and continuous time optimization, Hamiltonian, Bellman's principle of optimality, formulation of a DP, application of DP.

Textbooks

G.B. Dantzig, Linear Programming and Extensions, Princeton Landmarks in Mathematics, Princeton University Press, 1963

Practical Optimization P. E. Gill, W. Murray and M. H. Wright, Academic Press, 1981.

D. Bertsekas and J. Tsitsiklis Introduction to Linear Optimization, Athena Scientific, 1997.

Nonlinear Programming, D. Bertsekas, Athena Scientific, 2nd Edition, 1999.

R. Bellman, Dynamic Programming, Dover, 2003.

DE 13: STOCHASTIC PROCESS

1. Stochastic Process and Simple Markov Processes

Principles of actuarial modeling, stochastic vs. deterministic models; short run and long-run properties; stochastic process and counting process; analyzing the output of a model; sensitivity testing; types of stochastic processes: discrete state spaces with discrete and continuous time changes, continuous state space, sample paths, stationary, increments, Markov property.

2. Markov Chains

Chapman-Kolmogorov equations; time homogeneous Markov chains, modelling using Markov chains; estimating transition probabilities, assessing the fit and simulation

3. Two-State Markov Model

Assumptions, probabilities, joint density function, ML estimator; alternative approach, applications, two state model of a single decrement and comparison with those of a random lifetime model

4. General Properties of Markov Process

Poisson processes, deriving and solving the Kolmogorov equations for Markov process-time and age dependent and time independent transition intensities; Kolmogorov's backward differential equations, Markov jump process, the jump chain, simple two decrement model, calculation of total waiting time

5. Time-inhomogeneous Markov Jump Process

Chapman-Kolmogorov equations, transition rates, time inhomogeneous HSD model, Kolmogorov's backward and forward differential equations; a two state survival model; integrated form of Kolmogorov equations, applications-marriage, birth-and-death process and random walk, sickness and death; time homogeneous Poisson process models, time homogeneous and inhomogeneous Markov models.

Textbooks

Bass, Richard F., Stochastic processes, Cambridge, Cambridge University Press, 2011

Lawler, Introduction to Stochastic Processes, Ch. 1

Peter W. Jones & Peter Smith (2017) Stochastic processes: an introduction, Third edition, Boca Raton: Chapman & Hall/CRC Press, Series: Chapman & Hall/CRC Texts in Statistical Science series

Karlin & Taylor, A First Course in Stochastic Processes, Sec. 1.1A-F

Andersson and Britton, Stochastic Epidemic Models and Their Statistical Analysis, Ch. 2

Friedman, Stochastic Differential Equations and Applications, Ch. 2

Kloeden and Platen, Numerical Solution of Stochastic Differential Equations, Sec. 1.7,1.8, Sec. 2.3,2.4

DE 14: INTRODUCTION TO NON-LINEAR TIME SERIES ECONOMETRICS

The course objective is to introduce popular non-linear time series models. Topics include nonlinear unit roots, threshold and smooth transition models, multivariate GARCH models, Regime switching models, State Space models, factor models and other related issues.

1. Univariate Models

Models for Structural Changes, Bai-Perron tests, Forecasting with Linear and Nonlinear Models, Recent Developments in Unit Root tests: Breaks and Non-normal errors

2. Threshold and Smooth Transition Models

Threshold models

Testing for threshold, Confidence Intervals in TAR Models, Threshold unit root tests and extensions, Smooth transition, ESTAR and LSTAR models, Confidence Intervals in ESTAR/LSTAR Models, ESTAR and LSTAR unit root tests, Time-varying Coefficients Models

3. Fourier and Regime Switching Models

Fourier function Approach, Fourier unit root tests of Enders and Lee, Fourier function VAR models, Regime Switching Models, Markov Regime Switching Models

4. State Space and Unobserved Component models, Kalman filter and Factor Models

What is a state space model? What is the Kalman filter? Unobserved component and State Space Model, Trend Models, Dynamic factor model, Bivariate Unobserved Component Models, Factor VAR Models

5. GARCH and multivariate GARCH

Multivariate GARCH and different models, Time varying correlation

Textbooks

Enders, W. (2008). *Applied econometric time series*. John Wiley & Sons.

Franses, P.H. and D. van Dijk (2000). *Non-Linear Time Series Models in Empirical Finance*. Cambridge University Press.

Hamilton, James D. *Time Series Analysis*. Princeton University Press, 1994.

Kim, C.-J. and C.R. Nelson (1999). *State-Space Models with Regime-Switching: Classical and Gibbs-Sampling Approaches with Applications*. MIT Press.

Tong, H. (1990). *Non-Linear Time Series: A Dynamical System Approach*. Oxford University Press.

Wooldridge, J. (2015). *Introductory econometrics: A modern approach*. Nelson Education.

Douc, Randal, Eric Moulines, and David S. Stoffer (2014). *Nonlinear Time Series. Theory, Methods, and Applications with R Examples*. Boca Raton: Taylor & Francis Group.

Durbin, James, and Siem Jan Koopman (2012). *Time Series Analysis by State Space Methods*. Oxford: Oxford University Press. 2nd Edition.

Shumway, Robert H., and David S. Stoffer (2017). *Time Series Analysis and its Applications. With R Examples*. London: Springer. 4th Edition

DE 15: DISSERTATION/PROJECT (Under the supervision of a faculty)