INDIRA GANDHI INSTITUTE OF DEVELOPMENT RESEARCH

SEMESTER: I

COURSE TITLE: Mathematics for Economists

INSTRUCTOR(S): Dr. Gopakumar Achuthankutty

COURSE DESCRIPTION:

This course provides an in-depth exploration of fundamental concepts in mathematical analysis and linear algebra, including sequences, convergence, continuity, differentiation, and optimization. Students will investigate real number sequences, Cauchy sequences, and convergence criteria and delve into the properties of functions of a real variable, including continuity, differentiation, and Taylor's theorem. Linear algebra topics such as vector spaces, basis, dimension, and eigenvalues are examined alongside metric space theory and optimization techniques.

COURSE OBJECTIVES:

The course aims to develop student's analytical and problem-solving skills through a comprehensive exploration of mathematical analysis and linear algebra. Students will gain a deep understanding of sequences, convergence, and the properties of functions, equipping them with the ability to tackle complex problems in various professional contexts. The course also focuses on enhancing knowledge of vector spaces, linear transformations, and eigenvalues, which are crucial for careers in engineering, data science, and related fields. By introducing metric space theory and optimization techniques, including constrained and dynamic optimization, students will learn to address real-world challenges effectively. The course emphasizes the practical application of mathematical concepts to bridge theory and practice, thereby enhancing employability and fostering entrepreneurial skills. Through rigorous training and problem-solving, students will develop critical thinking and quantitative analysis capabilities essential for advanced studies and professional success.

COURSE OUTCOMES:

CO1 Provide a deep understanding of advanced mathematical concepts like metric spaces and linear algebra, which would serve as a foundation for more advanced topics like Functional Analysis, which are used extensively in decision theory and finance.

CO2 Develop practical skills in applying optimization techniques and linear algebra, including constrained and dynamic programming.

CO3 Enhance problem-solving skills, equipping students to tackle complex real-world problems in economics and finance.

COURSE REQUIREMENTS: No prerequisites.

COURSE CONTENTS:

Module 1: Sequences of Real Numbers and their convergence, Cauchy Sequences, Bolzano-Weierstrass Property, Continuity of a function of a real variable, Uniform and Lipschitz Continuity, Extreme and Intermediate Value Theorems, Differentiation of a function of a real variable, Mean Value Theorem, Taylor's Theorem.

Module 2: Vector Spaces and Subspaces, Basis and Dimension of Vector Space, Linear Transformations and their properties, Isomorphism, Linear Functionals, Dual Spaces, Determinants, Eigen Values and Eigen Vectors, Inner Products and Inner Product Spaces

Module 3: Metric Spaces, Cauchy-Schwartz Inequality, Convergence of Sequences in Metric Spaces, Open and Closed Sets, Continuity of functions on metric spaces, Differentiation of Vector-valued functions.

Module 4: Optimization under equality and inequality constraints and Kuhn-Tucker Theorem, Dynamic Optimization.

EVALUATION: Class Tests (30%), Mid-Semester Exam (35%), and Final-Semester Exam (35%).

REFERENCES:

- **A First Course in Analysis by John B Conway**
- **Elementary Real Analysis (Volumes 1 and 2) by Brian S Thomson, Judith B Bruckner, and Andrew M Bruckner**
- **Linear Algebra by Kenneth Hoffman and Ray Kunze Linear Algebra and its Applications by Gilbert Strang**
- **Finite Dimensional Vector Spaces by Paul Halmos**
- **Introductory Mathematical Economics by D Wade Hands**

Note: As per NAAC requirements, kindly focus on employability, entrepreneurship and skill development.

INDIRA GANDHI INSTITUTE OF DEVELOPMENT RESEARCH

Semester: Aug-Dec Semester, 2024

Course Title: Microeconomics 1

Instructor: Shubhro Sarkar (shubhro@igidr.ac.in)

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Phone: 6909-6543.

Teaching Assistants: Japneet Kaur (japneet@igidr.ac.in) and Shubham Sharma (shubham.s@igidr.ac.in)

Course Description

The focus of the course will be on Microeconomic Theory and its applications. While the course will be theoretical in emphasis, its coverage will be at the intermediate graduate level. We will spend some time discussing the intuition behind the various concepts while we define the same with formal, precise statements.

Course Objectives

The course aims to

(I) provide a rigorous introduction to the essential tools and techniques used in Microeconomic Analysis

(II) prepare students to read academic papers on various topics in Microeconomic Theory and related fields

(III) help students develop a step-by-step problem-solving approach.

Course Outcomes

Upon completion of the course, students should be able to

(a) appreciate some of the important results in Microeconomic Theory

(b) construct theoretical models that analyze the behavior of individual economic agents in various settings and, if possible, test them with appropriate empirical techniques

(c) comprehend the underlying intuition behind the salient micro-level issues in a policy debate.

Course Requirements

Calculus; Set Theory; Probability Theory; Linear Algebra; Unconstrained Optimization over a Single Variable

Course Contents

PART ONE: INDIVIDUAL DECISION MAKING

1. Preference and Choice
2. Consumer Choice

Commodities
The Consumption Set
Competitive Budgets
Demand Functions and Comparative Statics
The Weak Axiom of Revealed Preference and the Law of Demand

3. Classical Demand Theory

Preference Relations: Basic Properties
Preference and Utility
The Utility Maximization Problem
The Expenditure Minimization Problem
Comparative Statics – Implicit Function Theorem
Duality: A Mathematical Introduction
Relationships between Demand, Indirect Utility and Expenditure Functions
Integrability
The Strong Axiom of Revealed Preference

4. Production

Production Sets
Profit Maximization and Cost Minimization
The Geometry of Cost and Supply in the Single-Output Case
Aggregation
Efficient Production

PART TWO: GAME THEORY

7. *Static Games of Complete Information*

7.1 Normal/Strategic form games and Nash Equilibrium
7.2 Pure and Mixed Strategies
7.3 Iterated Elimination of Strictly Dominated Strategies (IESDS)

7.4 Nash Equilibrium – pure and mixed strategies

8. *Dynamic Games of Complete Information*

8.1 Complete and Perfect Information
8.2 Game Trees/Extensive Form Representation
8.3 Backwards Induction
8.4 Complete and Imperfect Information
8.5 Subgame Perfection
8.6 Repeated Games
8.7 Renegotiation Proof Equilibrium

Evaluation

50% will be on the final examination, 30% on a mid-sem examination, and the remaining 20% on (four) assignments handed out in class.

Students may work together on homework assignments but must write their answers independently. Answers that are merely copies of one another will be treated as violations of academic integrity, and appropriate action will be taken.

As a general policy, there will be no make-up midterm exams. If you miss a midterm exam and have a valid excuse, your grade will be based on the remaining elements of the course. Students should plan to be on campus till the end of the semester. Travel plans do not constitute a valid excuse for missing an exam.

References

1. *Microeconomic Theory*, Andreu Mas-Colell, Michael D. Whinston and Jerry Green, Oxford University Press.

2. *Advanced Microeconomic Theory*, Geoffrey Jehle and Philip Reny, 2nd ed. Reading, MA: Addison-Wesley.

3. *Microeconomic Analysis*, Hal Varian, Third Edition, W.W. Norton and Company.

4. *Game Theory for Applied Economists*, Gibbons, Princeton.

5. *Game Theory*, Fudenberg and Tirole, MIT Press.

6. *A Course in Game Theory*, Osborne and Rubinstein, MIT Press.

7. *A First Course in Optimization Theory*, Rangarajan K. Sundaram, Cambridge University Press.

8. *Mathematics for Economists*, Carl P. Simon and Lawrence Blume, W.W. Norton and Co.

Expectations

I believe that learning is a team effort. Students are the most vital part of this effort. There is a lot that students can do to help create a good learning environment. This includes coming to lectures on time, handing in assignments on time, and participating actively in class discussions.

INDIRA GANDHI INSTIUTE OF DEVELOPMENT RESEARCH

SEMESTER: Fall 2024 (Aug-Dec 2024)

COURSE TITLE: Macroeconomics I

INSTRUCTOR: Sargam Gupta

TEACHING ASSISTANT: Snigdha Kalra and Ankita Mandal

COURSE DESCRIPTION: This course will cover the stylized facts governing the basics of output growth, consumption, investment and savings in various economies. It will later introduce the standard macroeconomic growth models to understand the mechanics of the empirical facts observed in the data both in closed and open economy set-up.

COURSE OBJECTIVES: This course intends to motivate students to learn the concepts and applications of major workhorse models of the macroeconomics discipline. The idea is to provide a solid grounding to tackle more complex and detailed material in this field.

COURSE OUTCOMES:

CO1 Understand and explore dynamics of the macroeconomic stylized facts

CO2 Get acquaint with the concept of equilibrium both dynamically efficient and inefficient

CO3 Comprehensive understanding of long-run growth models including exogenous and endogenous growth models.

COURSE REQUIREMENTS: Prerequisites for this course are a familiarity with multivariate calculus, real analysis and linear algebra.

COURSE CONTENTS: Broadly the lectures will cover the following macro-economic growth models:

- Solow-Swan growth model: theory and empirics
- Ramsey-Cass-Koopmans growth model and extensions

• Overlapping generations model

• AK model, Endogenous growth models

• Open economy macro growth model

Software: The course would also introduce the basic programming of macroeconomic models in MATLAB or GNU-Octave.

EVALUATION: Class Participation and attendance: 5%

Homeworks/ Quizzes: 15%

Mid-Term Exam: 35%

Final Exam: 45 %

REFERENCES:

Core textbooks

1. Acemoglu, Daron. (2010). Introduction to Modern Economic Growth Princeton University Press. ISBN: 9780691132921.

2. Barro, Robert J. and Xavier Sala-i-Martin (2004), Economic Growth, 2nd Edition.

3. Romer, David. (2012), Advanced Macroeconomics, 4th Edition.

Additional textbooks

1. Aghion, P and Howitt (1998), Endogenous Growth Theory, MIT Press.

2. Ljungqvist, L and T Sargent (2012), Recursive Macroeconomic Theory, MIT Press.

3. Stokey, N and R E Lucas (1989), Recursive Methods in Economic Dynamics, Harvard University.

4. Vegh, Carlos (2013),Open Economy Macroeconomics in Developing Countries, MIT Press.

Reading list

1. Solow, R. M. (1956). A Contribution to the Theory of Economic Growth. Quarterly Journal of Economics, 70, 1, 65-94

2. Mankiw, N.G., D. Romer and D. N. Weil. (1992). A Contribution to the Empirics of Economic Growth. Quarterly Journal of Economics, 107, 2, 401-437.

3. Ramsey, F.P. (1928). A Mathematical Theory of Saving. Economic Journal. 38, 152, 543-559.

4. Cass, D. (1965). Optimum Growth in an Aggregative Model of Capital Accumulation. Review of Economic Studies. 32, 233-240.

5. Romer, P. M. (1986). Increasing Returns and Long-Run Growth. Journal of Political Economy. 94, 5, 1002-1037.

6. Barro, R.J. (1990). Government Spending in a Simple Model of Endogenous Growth. Journal of Political Economy. 98, 5, part 2, 103-125.

7. Jones, Charles I. (1995). RD-Based Models of Economic Growth. Journal of Political Economy. 103, 759-784

8. Jones, L. and R. Manuelli. (1990). A Convex Model of Equilibrium Growth. Journal of Political Economy. 98, 1008-1038.

9. Romer, P.M. (1990). Endogenous Technological Change. Journal of Political Economy. 98, 5, part 2, 71-102.

10. Aghion, P. and P. Howitt. (1992). A Model of Growth Through Creative Destruction. Econometrica. 60, 2, 323-351.

11. Young, A. (1991). Learning-by-doing and the Dynamic Effects of International Trade, Quarterly Journal of Economics. 106, 2, 369-406.

12. Grossman, G.M. and E. Helpman. (1990). Comparative Advantage and Long-Run Growth. American Economic Review. 80, 4, 796-815

13. Krugman, P.R. (1979). A Model of Innovation, Technology Transfer, and the World Distribution of Income. Journal of Political Economy. 87, 2, 253-266.

14. Grossman, G.M. and E. Helpman. (1991). Endogenous Product Cycles. Economic Journal. 101, 408, 1214-1229.

Reference books for Mathematics

1. Fuente, Angel de. (2000). Mathematical Methods and Models for Economists. Cambridge University Press.

2. Chiang, C. Alpha (1984). Fundamental Methods of Mathematical Economics. McGraw-Hill Publishing Co.

3. Pontryagin, Lev S., et al. (1962). The Mathematical Theory of Optimal Processes. New York: Interscience Publishers.