# UNIVERSITY OF KERALA

**Outcome based Curriculum Framework for**

## First Degree Programme (Double Main) in

# B.A. Economics and Mathematics

**(UNDER CBCS SYSTEM)**

**(Syllabus effective from 2020 Admission)**

## Proposed Scheme and Syllabus for First Degree Programme

## (Double Main) in B.A. Economics and Mathematics(CBCS System)

| Semester | Paper Code | Title | Hours | Credit | | Maximum Marks | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | CA | ESA | Total |
| I | EN 1111 | Lang I English I | 5 | 3 | | 20 | 80 | 100 |
| | 1111 | Language II | 5 | 3 | | 20 | 80 | 100 |
| | MEC 1121 | Informatics (Foundation Course-I) | 2 | 2 | | 20 | 80 | 100 |
| | MEC 1131 | Introduction to Economics | 3 | 3 | | 20 | 80 | 100 |
| | MEC 1132 | Introductory Microeconomics | 4 | 3 | | 20 | 80 | 100 |
| | MEC 1141 | Foundations of Mathematics | 3 | 3 | | 20 | 80 | 100 |
| | MEC 1142 | Theory of Numbers | 3 | 3 | | 20 | 80 | 100 |
| | | **Total** | **25** | **20** | | | | |
| II | EN 1211 | Lang I English II | 5 | 3 | | 20 | 80 | 100 |
| | 1211 | Language II | 5 | 3 | | 20 | 80 | 100 |
| | MEC 1221 | Introduction to Environmental Economics (Foundation Course-II) | 3 | 3 | | 20 | 80 | 100 |
| | MEC 1231 | Intermediate Microeconomics | 5 | 4 | | 20 | 80 | 100 |
| | MEC 1241 | Differential Equations | 3 | 3 | | 20 | 80 | 100 |
| | MEC 1242 | Vector Calculus | 4 | 4 | | 20 | 80 | 100 |
| | | **Total** | **25** | **20** | | | | |
| III | EN 1311 | Lang I English III | 5 | 3 | | 20 | 80 | 100 |
| | MEC 1331 | Introductory Macroeconomics | 4 | 3 | | 20 | 80 | 100 |
| | MEC 1332 | Economic Growth and Development | 3 | 3 | | 20 | 80 | 100 |
| | MEC 1333 | Game Theory | 3 | 3 | | 20 | 80 | 100 |
| | MEC 1341 | Multi Variable Calculus and Vector Calculus | 5 | 3 | | 20 | 80 | 100 |
| | MEC 1342 | Abstract Algebra – Group Theory | 5 | 4 | | 20 | 80 | 100 |
| | | **Total** | **25** | **19** | | | | |
| IV | EN 1411 | Lang I English IV | 5 | 3 | | 20 | 80 | 100 |
| | MEC 1431 | Intermediate Macroeconomics | 3 | 3 | | 20 | 80 | 100 |
| | MEC 1432 | Statistical Methods for Economics I | 4 | 4 | | 20 | 80 | 100 |
| | MEC 1433 | Financial Economics | 3 | 3 | | 20 | 80 | 100 |
| | MEC 1441 | Abstract Algebra – Ring Theory | 5 | 4 | | 20 | 80 | 100 |
| | MEC 1442 | Linear Algebra | 5 | 3 | | 20 | 80 | 100 |
| | | **Total** | **25** | **20** | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| V | MEC 1531 | International Economics | 4 | 4 | | 20 | 80 | 100 |
| | MEC 1532 | Statistical Methods for Economics II | 4 | 4 | | 20 | 80 | 100 |
| | MEC 1533 | Core I : Project | 3 | 3 | | 20 | 80 | 100 |
| | MEC 1551 | Open Course | 3 | 2 | | 20 | 80 | 100 |
| | MEC 1541 | Real Analysis – I | 6 | 4 | | 20 | 80 | 100 |
| | MEC 1542 | Complex Analysis – I | 5 | 4 | | 20 | 80 | 100 |
| | | **Total** | **25** | **21** | | | | |
| VI | MEC 1631 | Basic Econometrics | 7 | 4 | | 20 | 80 | 100 |
| | MEC 1632 | Indian Economy | 7 | 4 | | 20 | 80 | 100 |
| | MEC 1641 | Real Analysis – II | 5 | 4 | | 20 | 80 | 100 |
| | MEC 1642 | Complex Analysis – II | 5 | 4 | | 20 | 80 | 100 |
| | MEC 1643 | Project and Viva-II (Mathematics) | 1 | 4 | | 20 | 80 | 100 |
| | | **Total** | **25** | **20** | | | | |
| | | Grand Total | 150 | 120 | | | | 3600 |

## FIRST MAIN: ECONOMICS: SCHEME AND SYLLABUS

| Semester | Paper Code | Title | Hours | Credit | | Maximum Marks | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | CA | ESA | Total |
| I | MEC 1131 | Introduction to Economics | 3 | 3 | | 20 | 80 | 100 |
| | MEC 1132 | Introductory Microeconomics | 4 | 3 | | 20 | 80 | 100 |
| II | MEC 1221 | FC II Introduction to Environmental Economics | 3 | 3 | | 20 | 80 | 100 |
| | MEC 1231 | Intermediate Microeconomics | 5 | 4 | | 20 | 80 | 100 |
| III | MEC 1331 | Introductory Macroeconomics | 4 | 3 | | 20 | 80 | 100 |
| | MEC 1332 | Economic Growth and Development | 3 | 3 | | 20 | 80 | 100 |
| | MEC 1333 | Game Theory | 3 | 3 | | 20 | 80 | 100 |
| IV | MEC 1431 | Intermediate Macroeconomics | 3 | 3 | | 20 | 80 | 100 |
| | MEC 1432 | Statistical Methods for Economics I | 4 | 4 | | 20 | 80 | 100 |
| | MEC 1433 | Financial Economics | 3 | 3 | | 20 | 80 | 100 |
| V | MEC 1531 | International Economics | 4 | 4 | | 20 | 80 | 100 |
| | MEC 1532 | Statistical Methods for Economics II | 4 | 4 | | 20 | 80 | 100 |
| | MEC 1533 | Core I : Project | 3 | 3 | | 20 | 80 | 100 |
| VI | MEC 1631 | Basic Econometrics | 7 | 4 | | 20 | 80 | 100 |
| | MEC 1632 | Indian Economy | 7 | 4 | | 20 | 80 | 100 |
| | | Grand Total | 60 | 51 | | | | 1500 |

## SECOND MAIN- MATHEMATICS : SCHEME AND SYLLABUS

| Semester | Course Code | Title | Hours | Credit | | Maximum Marks | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | CA | ESA | Total |
| I | MEC 1121 | Informatics (Foundation Course-I) | 2 | 2 | | 20 | 80 | 100 |
| | MEC 1141 | Foundations of Mathematics | 3 | 3 | | 20 | 80 | 100 |
| | MEC 1142 | Theory of Numbers | 3 | 3 | | 20 | 80 | 100 |
| II | MEC 1241 | Differential Equations | 3 | 3 | | 20 | 80 | 100 |
| | MEC 1242 | Vector Calculus | 4 | 4 | | 20 | 80 | 100 |
| III | MEC 1341 | Multi Variable Calculus and Vector Calculus | 5 | 3 | | 20 | 80 | 100 |
| | MEC 1342 | Abstract Algebra – Group Theory | 5 | 4 | | 20 | 80 | 100 |
| IV | MEC 1441 | Abstract Algebra – Ring Theory | 5 | 4 | | 20 | 80 | 100 |
| | MEC 1442 | Linear Algebra | 5 | 3 | | 20 | 80 | 100 |
| V | MEC 1551 | Open Course | 3 | 2 | | 20 | 80 | 100 |
| | MEC 1541 | Real Analysis – I | 6 | 4 | | 20 | 80 | 100 |
| | MEC 1542 | Complex Analysis – I | 5 | 4 | | 20 | 80 | 100 |
| VI | MEC 1641 | Real Analysis – II | 5 | 4 | | 20 | 80 | 100 |
| | MEC 1642 | Complex Analysis – II | 5 | 4 | | 20 | 80 | 100 |
| | MEC 1643 | Project and Viva-II (Mathematics) | 1 | 4 | | 20 | 80 | 100 |
| | | Grand Total | 60 | 51 | | | | 1500 |

### STRUCTURE of OPEN COURSES

| Sem | Course Code | Course title | Instr.hrs. per week | Credit |
|---|---|---|---|---|
| V | MEC 1551.1 | Operations Research | 3 | 2 |
| V | MEC 1551.2 | Business Mathematics | 3 | 2 |
| V | MEC 1551.3 | Basic Mathematics | 3 | 2 |

# PROGRAMME SPECIFIC OUTCOMES (PSO)
# FOR B.A. ECONOMICS AND MATHEMATICS

| | |
|---|---|
| PSO1 | To provide a strong foundation in Economics and Mathematics |
| PSO2 | To enable students to acquire necessary skills foranalyzing basic economic issues at the micro and macro levels |
| PSO3 | To acquaint students with the essential mathematical and statistical methods and tools to be applied in the analytical aspects of Economics. |
| PSO4 | To enable students to acquire the technical and analytical skills to proceed to a successful career in finance, business and many other fields or to proceed to further study |
| PSO5 | To make the students capable of addressing and solving the issues in the society and the economy by contextualizing the knowledge they have acquired and finally |
| PSO6 | To create academic excellence through holistic education. |

## SYLLABUS OF CORE COURSE-I (ECONOMICS)

## Semester 1

### MEC 1131: Introduction to Economics

**3 Hours** **3 Credits**

**Course Outcomes (CO)**

**CO1:** The course intends to familiarize the students with the broad contours of Social Sciences, specifically Economics and its methodologies, tools and analysis procedures.

**CO2:**The course also aims to create an enthusiasm among students, incorporating various concepts and issues in economics.

**CO3:** To analyze the organization of the economy

**CO4:** To understand major global economic crisis and contemporary issues in economics

| MEC 1131: Tagging Course Outcomes | | | | | |
|---|---|---|---|---|---|
| **CO** | **CO Statement** | **PSO** | **Cognitive level** | **Knowledge Category** | **Assessment** |
| **CO1** | To familiarize the students with the methodologies, tools and analysis procedures in economics | PSO 2 | Understand | Analyze | Assignment on theDefinitions of Economics |
| **CO2** | To create an enthusiasm among students, incorporating various concepts and issues in economics. | PSO 1 | Understand | Conceptual | Assignment on: Economic systems- Traditional systems, Command systems, Pure market systems and Mixed systems |

| | | | | | |
|---|---|---|---|---|---|
| **CO3** | To analyze the organization of the economy | PSO 2 | Understand | Analyze | Discuss on the topic: Capitalism as an economic system |
| **CO4** | To understand major global economic crisis and contemporary issues in economics | PSO 5 | Understand | Analyze | *Assignment on* Great depression (1929) and the Global financial crisis (2008) |

**COURSE STRUCTURE**

**MODULE I: Methodology of Economics (15 Hours)**

Definitions of Economics; Subject matter and scope of Economics, Microeconomics and Macroeconomics, Economic advice: Positive and normative economics- Economic theorizing- endogenous and exogenous variables; Assumptions; Models

(Lipsey& Chrystal (2009) Economics, Eleventh Edition, Oxford University Press, New York, Chapter 1 & 2)

**MODULE II: Economic Issues and Concepts (15 hours)**

Resources and scarcity- Choice and opportunity cost- The production possibility boundary. Three key issues- what should be produced- Efficient production- Economic growth. Who makes the choices and how; Production Choices; Economic systems- Traditional systems, Command systems, Pure market systems and Mixed systems- Role of government in the modern mixed economy. Economic data –Index numbers – Graphing economic data – Graphing economic relationships

(Lipsey& Chrystal (2009) Economics, Eleventh Edition, Oxford University Press, New York, Chapter 1 & 2)

**Module III: Understanding the Organization of Economy (20 hours)**

Capitalism defined: Private property, markets and firms- Capitalism as an economic system- Gains from specialization- Technology, population and growth- Economic models-Basic

concepts: Prices, costs and innovation rents- Industrial Revolution and incentives for new technology.

(The Economy: Economics for a changing world by CORE team Chapter1 & 2)http://www.core-econ.org/the-economy/book/text/0-3-contents.html

**Module IV: Major Global Economic Events&Contemporary Economic Issues**

**(30Hours)**Great Depression- Golden age of high growth and low employment- stagflation and the end of golden age- Global financial crisis.The nation and the world economy- Globalisation and investment- Globalisation and migration- Trade and Growth.

Economic inequality- measuring inequality and living standards- Economics of environment- economy and environment- Innovation process: invention and diffusion- Innovation systems- Intellectual Property Rights.

(The Economy: Economics for a changing world by CORE team Chapter 17 & 18) http://www.core-econ.org/the-economy/book/text/0-3-contents.html

**References**

**Module I:**


- Blaug, M (1998): The Methodology of Economics, Cambridge Surveys of Economic Literature' New York.
- Kaufmann, Felix (1958): Methodology of the Social Sciences, The Humanities press, New York.
- Hunt, Elgin F (2008): Social Science and its Methods, Social Science and Introduction to the study of Society, Alyn and Bacon.


**Module II**


- Lipsey& Chrystal (2009) Economics, Eleventh Edition, Oxford University Press, New York.


**Module III, IV & V**


- The Economy : Economics for a changing world by CORE team

http://www.core-econ.org/the-economy/book/text/0-3-contents.html

## MEC 1132: INTRODUCTORY MICROECONOMICS

**4hours** **3 credits**

**Course Objective**

This course is designed to expose the students to the basic principles ofmicroeconomic theory. The emphasis will be on thinking like an economist and thecourse will illustrate how microeconomic concepts can be applied to analyze real-lifesituations.

| **Name of the Course: MEC 1132-Introductory Micro Economics** | |
|---|---|
| **Course Outcomes** | |
| **CO1** | To familiarise the basic themes of microeconomics |
| **CO2** | Empirical estimation of the elasticity of demand and supply |
| **CO3** | To study the theoretical framework of consumer behaviour |
| **CO4** | To analyse the basic theories of production function |
| **CO5** | To study the types of production costs |
| **CO6** | To study the structure of and determination of price and output under perfectly competitive and monopoly markets |

| **MEC 1132: Tagging Course Outcomes** | | | | | |
|---|---|---|---|---|---|
| **CO** | **CO Statement** | **PSO** | **Cognitive Level** | **Knowledge Category** | **Assessment** |
| **CO1** | Acquainting the students with the measurement and practical uses of demand and supply | PSO2 | Procedural | Analyse | Assignment on the simple mathematical treatment of demand and supply theory |
| **CO2** | Evaluating the types, measurement and practical uses of the concept of elasticity of demand and supply | PSO2 | Procedural | Analyse | Assignment on the practical uses and mathematical treatment of the concept of elasticity |

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|---|---|---|---|---|---|
| **CO3** | Studying the Cardinal. Ordinal and Revealed Preference theories of consumer behaviour. | PSO2 | Evaluate | Conceptual | Assignment on the comparative analysis of the theories of consumer behaviour. |
| **CO4** | Analyzing the basic theories of production function both in the short run and long run and the Cobb Douglas production function. | PSO2 | Understand | Analyse | Assignment on the practical uses and mathematical treatment of theories of production |
| **CO5** | Analysing the types of costs in production | PSO2 | Apply | Conceptual | Assignment on the mathematical treatment of cost theory |
| **CO6** | Examining the price and output determination in perfectly competitive and monopoly markets. | PSO2 | Apply | Conceptual | Assignment on the mathematical treatment of the determination of equilibrium price and output |

## COURSE STRUCTURE

**Module I: Introduction of Markets and Prices (15 hrs)**

What is Microeconomics? Themes of Microeconomics: Trade-offs; Theories and Models; Positive and Normative analysis- Market definition- competitive versus noncompetitive markets- real versus nominal prices.

The Basics of supply and demand- market mechanism – elasticities of supply and demand- point versus arc elasticities.Estimation of price, income and cross elasticities

**Module II: Consumer Behaviour (20hrs)**

Consumer behaviour: Consumer Preferences – Budget Constraints – Consumer choice – Utility maximization- Marsahll, Hicks and Samuelson - Revealed Preferences, Marginal Utility and Consumer Choice – Individual and Market Demand: Individual Demand - Income, Substitution and Price Effect-Normal Good, Inferior Good, Giffen good, Slutsky Equations, Ordinary Demand & Compensated Demand Functions,

**Module III: Production and Cost theory (15 hrs)**

Production: Technology of Production – Production with one variable input – Production with Two Variable Inputs – Returns to Scale –Homogenous and non-homogenous Production functions, Properties of linearly homogenous production functions, Euler's Theorem, output elasticity and elasticity of substitution, Producer equilibrium- output maximization, cost minimization and profit maximization, properties of Cobb-Douglas

The cost of production: Measuring Cost – Cost in the short - run and Long -run – Short Run and Long Run cost curves.

**Module IVMarket Structures I (25hrs)**

Competitive Markets: perfectly competitive markets-profit maximization – Choosing output in the Short Run and Long Run – Competitive firms Short Run supply curve – Industry's Long Run Supply Curve.

Monopoly – Average Revenue and Marginal Revenue – Monopolist's Output Decision - Monopoly Power – Price Discrimination –Equilibrium under discriminating monopoly

**Reference**


1. Robert S. Pindyck, Daniel L. Rubinfeld*Microeconomics, 8th Ed* , Pearson India Education Services Pvt Ltd
2. C. Synder and W Nicholson(S-N): Fundamentals of Microeconomics, Cengage Learning (India), 2010, Indian Edition


**Additional Readings**


1. Hal R Varian: Intermediate Microeconomics: A Modern Approach 8th edition, W.W.Norton and Company/Affiliated east-West Press (India), 2011.
2. Koutsoyiannis, A. (2011), Modern Microeconomics, Macmillan Press,London.
3. Chiang, A.C. (1986), Fundamental Methods of Mathematical Economics, Mc Graw Hill, New York.
4. Henderson, J. M. and R.E. Quandt (1980), Microeconomic Theory: A MathematicalApproach, McGraw Hill, New Delhi.

**Semester II**

# MEC 1221: Introduction to Environmental Economics (Foundation II)

**Instructional Hours – 3** **Number of Credit-3**

**Course Outcome**

CO 1: It will familiarize the students the association of the economy and environment

CO 2: Enable students to develop a comprehensive knowledge on the environmental theories for analysis

CO3: This would impart the skills essential for understanding and solving the environmental issues.

CO 4: Enable the students to impart knowledge about environmental policy tools and disaster management in India

| **MEC 1221: Tagging Course Outcomes** | | | | |
|---|---|---|---|---|
| CO | **CO Statement** | **Cognitive Level** | **Knowledge Category** | **Assessment** |
| CO 1 | By familiarizing the students the association of the economy and environment | Analysis | Procedural | An assignment on portraying the relationship between economy and environment. |
| CO 2 | By enabling the students to develop a comprehensive knowledge on the environmental theories for analysis | Analysis | Procedural | An essay on the environmental theories for analysis |
| CO3 | By imparting the skills essential for understanding and solving the environmental issues. | Evaluate | Procedural | An evaluation of skills to identifying the real environmental issues at global level. |

| | | | | |
|---|---|---|---|---|
| CO4 | Enabling the students to impart knowledge about environmental policy tools and disaster management in India | Evaluate | Procedural | An evaluation of their understanding on environmental policy tools and disaster management in India |

**Module I : Basic Concepts** **(15 Hours)**

Ecology and Environment - Traditional environmental economics; - Transition from Environmental to Ecological Economics – Ecosystems and ecosystem services

**Module II: Critique of Neoclassical Economics** **(18 Hours)**

Critique of neo-classical economics; from normative to value- relativistic approach to economics; "sacred economics" and other contemporary schools of economic thought - Keynes and the Development of the mixed economy.

**Module III : Concept of Externality** **(15 Hours)**

Pareto optimum and Market failure in the presence of Externalities - public goods - Property rights and the Coase theorem

**Module IV : Environmental Policy Tools and Environmental Issues** **(20 Hrs)**

Pigouvian Taxes , Tradable Permits – Types of Economic Values – Valuation Methods – Economics of Climate Change –Concept and Measurement of Sustainable Development - Concept and Definitions of Disaster, Hazard, Vulnerability, resilence and Risk - Vulnerability Profile Disaster management in India

***References***


- Ecology and the Politics of Scarcity. by William Ophuls. W. H. Freeman & Company, San Francisco, CA. 1977.
- Primitive, Archaic, and Modern Economies: Essays of Karl Polanyi. by Karl Polanyi, edited by George Dalton. Beacon Press, Boston, MA: 1968.
- Hussain, M, Ahmed. 2000. Principles of Environmental Economics, Routledge, London and New York
- Charles Kolstad, Intermediate Environmental Economics, Oxford University Press, 2nd edition
- Carter, Nick 1991. Disaster Management: Disaster Manager's Handbook, Asiaan Development Bank, Manila Pilippiens.
- Gupta Anil K, Sreeja S Nair, 2011 Environmental Knowledge for Disaster Management, NIDM, New Delhi

## MEC 1231: INTERMEDIATE MICROECONOMICS

**5 Hours** **4 Credits**

**Course Objective**

This course is designed to expose the students to the basic principles of microeconomic theory. The emphasis will be on thinking like an economist and the course will illustrate how microeconomic concepts can be applied to analyze real-life situations.

| **NAME OF THE COURSE: MEC 1231:INTERMEDIATE MICRO ECONOMICS** | |
|---|---|
| **CO1** | To understand general idea about monopolistic and oligopolistic markets |
| **CO2** | To study markets for factor inputs |
| **CO3** | To understand the concepts of Risk and uncertainty |
| **CO4** | To sudy the concepts of general equilibrium ,economic efficiency and market failure |

| **MEC 1231: Tagging Course Outcomes** | | | | | |
|---|---|---|---|---|---|
| Course Outcome | CO Statement | PSO | Cognitive Level | Knowledge Category | Assessment |
| **CO1** | Understanding the peculiar characteristics of monopolistic competition as a market form in comparison with monopoly | PSO 1 | Analyze | Conceptual | Class room discussion on the relevance of monopolistic competition in our daily life |
| **CO2** | Examine the peculiar characteristics of oligopoly as a market form in | PSO 1 | analyze | Conceptual | Class room discussion on the existence of oligopoly market form in our daily life |

| | | | | | |
|---|---|---|---|---|---|
| | comparison with monopolistic ally competitive firms | | | | with suitable example |
| **CO3** | Understanding the concept of competitive factor market | PSO 1 | Understand | Conceptual | Assignment on different types of factor markets |
| **CO4** | Identifying the situation of equilibrium in factor market | PSO 5 | Evaluate | Conceptual | Class room discussion on different situations of disequilibrium in the labour market |
| **CO5** | Learning Net present value criterion for capital investment decisions | PSO 2 | Understanding | Conceptual | Class room discussion on capital investment decisions |
| **CO6** | Understand the concepts of risk, probability ,expected value and variability in possible outcom**e** | PSO 1 | Understand | Conceptual | Class room discussions on practical awareness on risk, probability ,expected value and variability |
| **CO7** | Learning general equilibrium analysis in terms of efficiency of exchange, | PSO 1 | Analyse | Conceptual | Assignment on General equilibrium analysis |

| | | | | | |
|---|---|---|---|---|---|
| | efficiency of production and efficiency of product mix | | | | |

**COURSE STRUCTURE**

**Module I: Market Structures II (30Hrs)**

Monopolistic Competition –Equilibrium in the Short Run and Long Run – Oligopoly – Equilibrium in an Oligopolistic Market – Price Competition – Price Rigidity, Cournot and Stackelberg models.

(Microeconomics; Robert S. Pindyck, Daniel L. Rubinfeld ; 8th Edition; Chapter 12)

**Module II: Markets for Factor inputs: (25 Hrs)**

Competitive Factormarkets – Equilibrium in factor markets – Investment, time and capital markets: Stocks vs Flows – Present Discounted value – Net Present Value criterion- How are interest rates determined

(Microeconomics; Robert S. Pindyck, Daniel L. Rubinfeld 8th Edition; Chapter 14 & 15)

**ModuleIII: Risk and Uncertainty (20 hrs)**

Risk- Probability – Expected Value – Variability - Preferences towards Risk – Reducing Risk - The Demand for Risky Assets – Behavioural Economics.

(Microeconomics; Robert S. Pindyck, Daniel L. Rubinfeld ; 8th Edition; Chapter 5)

**Module IV: General Equilibrium, Economic Efficiency and Market Failure: (25hrs)**

General Equilibrium and Economic Efficiency - General Equilibrium analysis - Efficiency in exchange – Efficiency in production – Efficiency in product-mix . The Gains from trade – Market failure – Externalities – Public Goods.

(Microeconomics / Robert S. Pindyck, Daniel L. Rubinfeld 8th Edition; Chapter 16)

**Reference**


1. Robert S. Pindyck, Daniel L. Rubinfeld*Microeconomics, 8th Ed* , Pearson India Education Services Pvt Ltd

**Additional Readings:**

1. Hal R Varian: Intermediate Microeconomics: A Modern Approach 8th edition, W.W.Norton and Company/Affiliated east-West Press (India), 2010

2. C. Synder and W Nicholson(S-N): Fundamentals of Microeconomics, Cengage Learning (India), 2010, Indian Edition

3.Koutsoyiannis, A. (2011), Modern Microeconomics, Macmillan Press, London.

4.Chiang, A.C. (1986), Fundamental Methods of Mathematical Economics, Mc Graw

Hill, New York.

# Semester III

## MEC 1331: INTRODUCTORY MACROECONOMICS

**4 Hours** **3 Credits**

**Course Objective**

This is the first module in a two-module sequence that introduces students to thebasic concepts of Macroeconomics. Macroeconomics deals with the aggregateeconomy. This course discusses the preliminary concepts associated with thedetermination and measurement of aggregate macroeconomic variable like GDP,savings, investment, money, inflation, and the balance of payments. It also introducesstudents to simple analytical frameworks for determination ofequilibrium output.

| **Name of the course**: **MEC 1331: INTRODUCTORY MACROECONOMICS** | |
|---|---|
| **Course Outcomes** | |
| **CO 1** | To understand the concept of national income and different methods of measuring it. |
| **CO 2** | To summarize the contributions made by the classical economists in macroeconomics. |
| **CO 3** | To summarize the contributions made by the Keynesian economists in macroeconomics. |
| **CO 4** | To understand the concept of money and the factors contributing demand for money |

| **MEC 1331: Tagging Course Outcomes** | | | | | |
|---|---|---|---|---|---|
| **CO** | **CO Statement** | **PSO** | **Cognitive Level** | **Knowledge Category** | **Assessment** |

| | | | | | |
|---|---|---|---|---|---|
| **CO 1** | Understanding the concept of national income and different methods of measuring it and its relevance in the Indian context. | **PSO 1** | Understand | Conceptual | Assignment on the measurement of the national income in India and its limitations in the present system |
| **CO 2** | Summarizing the contributions made by the classical economists in macroeconomics. | **PSO 1** | Understand | Factual | Assignment on the criticisms raised against the classical theory of income, output, and employment |
| **CO 3** | Summarizing the contributions made by the Keynesian economists in macroeconomics. | **PSO 1** | Understand | Factual | Assignment on the practical application of Keynesian Economics |
| **CO 4** | Understanding the concept of money and the factors contributing demand for money | **PSO1** | Understand | Conceptual | Assignment on the Theories of Money Demand |

# COURSE STRUCTURE

**Module I: The Data of Macroeconomics(20 hrs)**

What is Macroeconomics? The economy's income and expenditure; The measurement of GDP; Components of GDP; real versus nominal GDP; GDP Deflator; Is GDP a good measure of economic well-being? Measuring the cost of living- The Consumer price index; Real and Nominal interest rates.

**(**GregoryMankiw, N. (2018). Principles of *Macroeconomics, 7th ed.* Cengage. Chapter10 & 11)

**MODULE II: Classical Macroeconomics: Equilibrium Output and Employment (22 Hours)**

Classical approach – Say's Law – Wage – Price Flexibility –Saving-Investment Equality – Classical Theory of Employment and Output determination – Classical Dichotomy - Keynesian objection to Classical Theory.

**MODULE III:Keynesian Macro Economic system (23 Hours)**

Simple Keynesian model of income determination and Keynesian Cross – The components of Aggregate demand- Determining equilibrium Income; Changes in equilibriumIncome - Role of taxation and Government spending in the determination of National Income ;The Multiplier and the algebraic derivation of the same. Determination of National Income in the Open Economy.

**MODULE II: Money, Prices and Interest Rate (20 Hours)**

Money – Definition – Functions –Quantity Theory of Money – Cambridge Version – Liquidity Preference – Liquidity trap –Friedman's Restatement of the Quantity Theory.

**References**


1. Gregory Mankiw, N. (2018). Principles of *Macroeconomics, 7th ed.* Cengage.
2. Richard Froyen , Macroeconomics: Theories and Policies, 10th ed, Pearson Education


**Additional Readings**


1. Abel, A., Bernanke, B. (2016). *Macroeconomics, 8th ed*. Pearson Education.

2. Dornbusch, R., Fischer, S., Startz, R. (2018). *Macroeconomics, 12th ed*.McGraw-Hill

## MEC 1332: Economic Growth and Development

**3 Hours** **3 Credits**

**Course Outcome:**

**CO1-** To enable students to understand the basic concepts of Economic Growth and Development

**CO2-** To examine the different tools for measuring economic growth and development.

**CO3-** To impart knowledge about theoretical framework of Growth and Development under different Schools of economic thought.

| | **MEC 1332: Tagging Course Outcomes** | | | | |
|---|---|---|---|---|---|
| Course Outcome | **CO Statement** | **PSO** | **Cognitive Level** | **Knowledge Category** | **Assessment** |
| CO 1 | By enabling the students to understand the concepts of growth and development, basic characteristics of LDCs, obstacles to grow and the Development Gaps | **PSO 1** | Evaluate | Procedural | An evaluation of the characteristics of LDCs |
| CO 2 | By familiarizing students with the different tools used in measuring growth and development. | **PSO 1** | Analysis | Procedural | Assignment on analyzing thecalculaton of different development indices and a comparison between them. |
| CO 3 | By imparting an understanding of the different growth models | **PSO 1** | Analysis | Procedural | An analysis of the applicability of the theories in the present world. |

**COURSE STRUCTURE**

**MODULE I : CONCEPTIONS OF DEVELOPMENT** **(18 Hours)**

Meaning, Definition and Scope of Economic Growth and Development, Development Gap, Alternative Measures of Development, Comparing Development Trajectories across nations and within them.

**MODULE II : TOOLS FOR MEASURING DEVELOPMENT (15 Hours)**

Measurement of Poverty – absolute and relative; Head-Count Index and Poverty Gap Indices Sen's Capabilities approach; Measurement of Income inequality – Kuznet's inverted U Hypothesis, Lorenz Curve, Gini Coefficient, Physical Quality Life Index, Human Development Index, Happiness Index, Gender Development Index.

**MODULE III : GROWTH MODELS (20 Hours)**

Classical theories of Growth, Adam Smith, David Ricardo and Karl Marx; Neo-Classical Model of R.M. Solow; Neo-Keynesian Model of Joan Robinson, Harrod Domar Model; Endogenous Growth Models and evidence on the determinants of Growth.

**MODULE IV : THEORIES OF ECONOMIC GROWTH AND DEVELOPMENT (22 Hours)**

Rostow's Stages of Growth, The Vicious Circle of Poverty, Nelson's Low Level Equilibrium Trap, Lewis Theory of Unlimited Supply of Labour, Nurk's Theory of Disguised Unemployment, Leibenstein's Critical Minimum Effort Thesis. The Big Push Theory, Balanced and Unbalanced Growth, Dualistic Theories.

**References**


1. Debraj Ray, Development Economics, Oxford University Press, 2009.
2. Todaro and Smith, Economic Development, Pearson Education, New Delhi (recent edition)
3. Thirwall (2006), Growth and Development with Special Reference to Developing countries, Mcmillan, New Delhi.

## MEC 1333: Game Theory

**3 Hours** **3 Credits**

**Course Objective**

Game theory introduces the students to optimal decision making in interactive settings. This course will deal with the solution concepts for normal form and extensive form games, along with a variety of applications. Ideas related to asymmetric information among the interacting agents will also be analysed in this course. The course ends with the application of game theory to analyse moral hazard, adverse selection and signalling problems.

| NAME OF THE COURSE: MEC 1333: Game Theory | |
|---|---|
| CO1 | To understand basic concepts of gaming and strategic decisions |
| CO2 | To study Nash equilibrium, strategies and mixed strategies |
| CO3 | To understand repeated games and sequential games |
| CO4 | To learn information economics |

| MEC 1333:Tagging Course Outcomes | | | | | |
|---|---|---|---|---|---|
| **CO** | CO Statement | PSO | Cognitive Level | Knowledge Category | Assessment |
| **CO1** | Understanding the basic concepts of gaming like payoffs ,strategy and pay off matrix | PSO 1 | Understand | Conceptual | Assignment on pay off matrix |

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|---|---|---|---|---|---|
| **CO2** | Studying cooperative and non cooperative games and dominant strategy equilibrium | PSO 1 | Analyze | Conceptual | Class room discussion on cooperative and no cooperative games |
| **CO3** | Examine the conditions of Nash equilibrium ,mixed strategies and prisoner's dilemma | PSO 1 | Analyze | Conceptual | Assignment on mixed strategies and Nash equilibrium |
| **CO4** | To understand Repeated games ,Tit for tat practice and sequential games | PSO 1 | Analyze | Conceptual | Class room discussion on repeated games and sequential games |
| **CO5** | Understanding information economics with special reference to adverse selection, market signalling and moral hazard | PSO 3 | Understand | Conceptual | Assignment on adverse selection and moral hazard |

**COURSE STRUCTURE**

**Module 1:** Gaming and strategic decisions - Basic concepts (Agents, payoffs and strategy, payoff Matrix), Cooperative and Non Cooperative Games- Dominant strategy equilibrium

**(20 hours)**

**Module II:** Nash equilibrium- Maximin strategies- Prisoner's dilemma- Mixed strategies- Battle of the sexes. **(15 hours)**

**Module III**: Repeated Games – Tit for tat practice – Sequential games – Extensive form of a game- The advantage of moving first – Threats, Commitment and Credibility – Entry deterrence

**(20 hours)**

**Module IV:** Information economics - Adverse selection; Market Signaling; moral hazard.

**(20 hours)**

**References**


1. Robert S. Pindyck, Daniel L. Rubinfeld*Microeconomics, 8th Ed* , Pearson India Education Services Pvt Ltd
2. Osborne, M. (2004). *An introduction to game theory*. Oxford University Press.

# Semester IV

## MEC 1431: INTERMEDIATE MACROECONOMICS

**3 Hours** **3 Credits**

**Course Objective**

This is the second module on Macroeconomics. This course introduces students to formal modeling of the macro economy in terms of analytical tools. It discusses various alternative theories of output and employment determination in a closed economy in the short run as well as medium run, and the role of policy in this context. It also introduces students to various micro-founded theories of macro behaviour, e.g., consumption and investment behaviour of households and the demand for money generated in the household sector.

| **Name of the course**: **MEC 1431: INTERMEDIATE MACROECONOMICS** | |
|---|---|
| **Course Outcomes** | |
| CO 1 | To understand the concept of Goods market and money market equilibrium |
| CO 2 | To assimilate the notion of Aggregate demand and Aggregate supply in the Economy |
| CO 3 | To strengthen the awareness about the basic economic issues like inflation, unemployment and trade cycle. |
| CO 4 | To understand the concept and theories of consumption function and investment |

| **MEC 1431: Tagging Course Outcomes** | | | | | |
|---|---|---|---|---|---|
| **CO** | **CO Statement** | **PSO** | **Cognitive Level** | **Knowledge Category** | **Assessment** |
| **CO 1** | Understanding the concept of Goods market and money market equilibrium and IS-LM model | **PSO 1** | Understand | Conceptual | Studying the effectiveness of macroeconomic policies in tackling fundamental economic issues. |

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|---|---|---|---|---|---|
| **CO 2** | Assimilating the notion of Aggregate demand and Aggregate supply in the Economy. | **PSO 2** | Understand | Conceptual | Assignment on the determination of equilibrium output, price level and employment in an economy |
| **CO 3** | Strengthening the awareness about the basic economic issues like inflation, unemployment and trade cycle. | **PSO 2** | Understand | Conceptual | Assignment on stagflation. |
| **CO 4** | Understanding the concept and theories of consumption and investment | **PSO 1** | Understand | Conceptual | Assignment on various factors determining consumption function and investment in an Economy |

**COURSE STRUCTURE**

**Module I: Neoclassical-Keynesian synthesis or the IS LM approach (30hrs)**

IS-LM Analytics, Definition and derivation of IS and LM curve as well as its slope and shifts. Algebraic derivation of the fiscal and monetary policy multiplier. Fiscal and monetary policy,crowding in and crowding out.

**Module II: Aggregate demand and aggregate supply curves (18 hrs)**

Derivation of aggregate demand and aggregate supply curves; interaction of aggregate demand and supply to determine equilibrium output, price level and employment.

**Module III: Inflation, Unemployment and Trade Cycle. (20 Hours)**

Inflation and its social costs; Causes and types of inflation; Unemployment- types of unemployment – Phillip's Curve – Short run and Long run – Trade Cycle – Meaning and Phases – Theories of Trade Cycle- Hicks, Hawtrey and Hayek.

**Module IV: Microeconomic foundations (22hrs)**

Consumption: Keynesian consumption function; Fisher‘s theory of optimal intertemporal choice; lifecycle and permanent income hypotheses; rational expectations and random walk of consumption expenditure

Investment: business fixed investment; residential investment and inventory Investment- Determinants of Investment- Keynesian Investment Function - MEC and MEI- Accelerator – Dampeners on accelerator – Super multiplier.

**References**


1. Mankiw, N. (2018). Principles of *Macroeconomics, 7th ed.* Cengage.
2. Froyen, Richard T (2006 ) Chapter on the Keynesian System (II): Money, Interest and Prices and The Keynesian System (III): Policy Effects in IS-LM model
3. Abel, A., Bernanke, B. (2016). *Macroeconomics, 8th ed*. Pearson Education.
4. Dornbusch, R., Fischer, S., Startz, R. (2018). *Macroeconomics*, *12th ed*.McGraw-Hill.

## MEC 1432: Statistical Methods for Economics I

**4 Hours** **4Credits**

**Course Objective**

The course teaches students the basics of probability theory and statistical inference. It sets a necessary foundation for the econometrics course. The familiarity with probability theory will also be valuable for coursesin advanced microeconomic theory.

| **Name of the course**: **MEC 1432: Statistical Methods for Economics** | |
|---|---|
| **Course Outcomes** | |
| CO 1 | To study the tabular and graphical presentation of the data |
| CO 2 | To understand the measures of Central Tendency Dispersion in order to interpret empirical data |
| CO 3 | To study the elementary theory of probability including probability distributions. |
| CO 4 | To understand the concept of sampling and estimation |

**MEC 1432: Tagging Course Outcomes**

| **CO** | **CO Statement** | **PSO** | **Cognitive Level** | **Knowledge Category** | **Assessment** |
|---|---|---|---|---|---|
| **CO 1** | Understanding the measures of Central Tendency and Dispersion in order to interpret empirical data | **PSO 3** | Understand | Analyze | Assignment of collection of some data for which the various measures of central tendency can be computed. |

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|---|---|---|---|---|---|
| **CO 2** | Studying the elementary theory of probability including probability distributions | **PSO 3** | Understand | Conceptual | Assignment on various cases in economics in which different probability distributions can be applied. |
| **CO 3** | Understanding the concept of sampling and estimation | **PSO 3** | Understand | Procedural | Assignment on various tests used for estimation |
| **CO 4** | To develop essential data handling skills using spreadsheet software. | **PSO 3** | Applying | Analyze | Assignment using spreadsheet software |

**COURSE STRUCTURE**

**Module I: Descriptive statistics: Tabular and Graphical presentations (20 hrs)**

Summarizingcategorical data- Frequency Distribution, Relative Frequency and PercentFrequency Distributions,Bar Charts and Pie Charts; SummarizingQuantitative Data-Frequency Distribution, Relative Frequency and Cumulative Frequency Distributions, Dot Plot, Histogram, Cumulative Distributions, Ogive; Cross tabulations andScatter diagrams; Box plot

**Module II: Descriptive statistics: Numerical Measures**

Measures of Location and Variability, Percentiles, Skewness and Kurtosis, z-scores, Chebyshev's Theorem, Measurement of income inequality using Lorenz Curve and Gini co-efficient; Measures of Association between two variables (Covariance and Correlation)

**Module III: Probability Theory, Discrete and Continuous Probability Distributions (25 hrs)**

Basic Relationships of probability; Concepts of Joint, Marginal and Conditional probability and Independence, Bayes' Theorem, Concept of Random Variables and Features of probability distributions (Expected values, Variances and their properties); Discrete (Binomial and Poisson) and Continuous Probability Distributions (Uniform, Normal and Exponential) and their applications.

**Module IV: Sampling and Estimation (30 hrs)**

Concepts of Population vs Sample, Sampling Methods- Random Sampling-simple and restricted (systematic, Stratified, Multistage and Cluster), Non-random sampling- Judgment, Convenience , Quota and Snow-ball Sampling Methods; Unknown Parameters vs Sample Statistics, Estimators vs Estimates; Point and Interval Estimation and Properties of Estimators; Sampling Distribution of Sample Mean and Proportion; Standard error, t, F and Chi-square distributions, Central Limit Theorem; Interval Estimation and Confidence Intervals for population parameters.

**Reference**


1. Anderson, D., D.Sweeney and T.Williams (2013): "Statistics for Business and Economics", Cengage Learning : New Delhi.


**Additional Readings**


2. Bryman A (2004) Social Research Methods. Oxford: Oxford University Press
3. Neuman, (2014), Social Research Methods : Qualitative and Quantitative Approaches, Pearson. Devore, J.L. (2010), Probability and Statistics for Engineers, Cengage Learning.
4. Nagar, A.L. and R.K. Das (1993), Basic Statistics, Oxford University Press, New Delhi.
5. Freund, J.E. : "Mathematical Statistics", (Latest Edition), Prentice Hall : India.
6. Yates, Frank(1971), Sampling Methods for Census and Surveys, Charles, Griffin Co.

## MEC 1433: Financial Economics

**Instructional Hours- 3** **Number of Credit - 3**

**Course Outcome**

**CO1:** To familiarize the students with the basic concepts in financial economics

**CO2:** To provide comprehensive knowledge on the role of finance and financial systems in operation

**CO3:**The course intends to familiarize the students with the basic concepts in money market and capital market

**CO 4:** To enable students to know the operation of the Indian Financial System and activities in the financial markets.

| **MEC 1433:Tagging Course Outcomes** | | | | | |
|---|---|---|---|---|---|
| **Course Outcome** | **CO Statement** | **PSO** | **Cognitive level** | **Knowledge Category** | **Assessment** |
| **CO1** | To understand the various instruments in the money market | PSO 4 | Understand | Conceptual | Assignment on: Features of Indian Money market. |
| **CO2** | To understand the basic concepts of the capital market | PSO 4 | Understand | Conceptual | *Assignment on* the functions of SEBI |
| **CO3** | To enable students to know the operation of the | PSO 4 | Understand | Conceptual | *Assignment on* IndianFinancial system. |

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|---|---|---|---|---|---|
| | Indian Financial System | | | | |

**COURSE STRUCTURE**

**Module I: Financial system and Financial Markets (6 Hours)**

Financial system-Structure-Functions- Financial markets- Financial Instruments -Financial system and Economic development - Money market-Meaning-Functions-Instruments of money market-Call loans, Collateral loans, Promissory notes, Bills of Exchange, Treasury Bills, Gilt edged securities, RBI in Indian Money market.

**Module II: Capital Market (8 Hours)**

Capital market- Meaning – Functions-Structure-Primary and Secondary markets - Instruments of Capital market- Bonds and debentures, Government promissory notes, Public sector bonds-Initial Public Offer-Methods of floatation of shares – Secondary Market- Nature and functions of stock exchanges -Settlement and trading in stock exchange- Players in stock exchanges-Speculators-Bulls, Bears, Lame duck, Stag- Kerb trading, Insider trading- Listing of securities

**Module III: Security Market Analysis (8 Hours)**

Risk-Return on risk-types of risk-Security Evaluation-Fundamental Analysis, Technical Analysis -Fundamental Analysis- Dow Theory, Dow-Jones Index, Elliot Wave Theory-Derivatives-Options, Futures/Forwards, Swaps Construction of Stock market indices.

**Module IV: Indian Financial System (8 Hours)**

Structure of Indian Financial System-Organization and management of Indian Stock Exchanges- Depositories in India NSDL, CSDL- Development financial institutions -Pension and Provident Funds, National Pension system and PFRDA (Pension Funds Regulatory and Development Authority) Mutual funds- Venture capital funds- NBFIS, Chit Funds-Credit rating agencies in India

*References*


- • Bhole, L M (1999): Financial Institutions and Markets, TATA Mc Graw Hill Co Ltd, New Delhi
- • Gupta, S B (2007): Monetary Economics Institutions Theory and Policy, Chand and Co Ltd
- • Khan, N Y (1996): Indian Financial system, TATA Mc Graw Hill Co Ltd, New Delhi
- • Bharathi V Pathak( 2003):Indian Financial system, Pierson Education, New Delhi
- • Preethi Singh (2009) : Dynamics of Indian Financial system, markets, institutions and services, Annes Books Pvt Ltd, New Delhi

## Semester V

### MEC 1531: International Economics

**4 Hours** **4 Credits**

**Course Outcomes**

**CO 1 –** To enable students to understand the basic concepts related to international trade.

**CO 2-** To familiarise students with policies that influence trade between countries.

**CO3-** To familiarise students about Balance of Payment and intricacies of exchange rate determination

**CO 4-**To enable students to have a basic understanding of the emerging trends in the field of international economic system.

| **MEC 1531:Tagging Course Outcomes** | | | | | |
|---|---|---|---|---|---|
| Course Outcome | **CO Statement** | **PSO** | **Cognitive Level** | **Knowledge Category** | **Assessment** |
| CO 1 | By enabling the students to understand the basic concepts related to International trade and the traditional theories of trade | **PSO 1** | Analysis | Procedural | An assignment on the application of Traditional theories in the present world. |
| CO 2 | By evaluating the trade policies and their effects on trade. | **PSO 5** | Evaluate | Procedural | An evaluation of free trade and protection in India. |

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|---|---|---|---|---|---|
| CO3 | Enabling the students to imbibe the concept of BoP, its disequilibrium condition, measures to correct it and a detailed examination of the foreign exchange rate. | **PSO 1** | Analysis | Procedural | An analysis of economic crisis due to BOP disequilibrium in different countries of the world,w.r.t., India |
| CO4 | Enabling students to have a basic understanding of the emerging trends in the field of international economic system. | **PSO 1** | Evaluate | Procedural | An evaluation of changes in International economics over the years. |

**COURSE STRUCTURE**

**Module I: Theories of International Trade** (23 Hours)

International Economics- Subject matter- basis of trade- trade as an engine of growth- pure theory of international trade- Mercantilism and Physiocrats - Classical theory: Absolute and Comparative advantage theories- Modern theory of International trade- Heckscher Ohlin theory- Leontieff paradox.

Terms of trade- offer curve- Community indifference curve- opportunity cost (Concepts only), Gains from trade- Static and Dynamic gains- trade as an engine of growth, Foreign trade multiplier.

**Module II: Balance of Payments** (20 Hours)

Balance of payments,- components- Accounting framework- Current Account deficit, - Disequilibrium- causes- measures to correct disequilibrium, Automatic and deliberate measures- Devaluation- Effects of devaluation- Marshall –Lerner condition- J curve effect- Absorption approach- FDI ,FII and MNC.

**Module III: Foreign Exchange** (25 Hours)

Exchange rate determination- Mint parity theory- Purchasing power parity theory- BOP theory- exchange rate system- fixed and flexible exchange rate, Managed floating system- Nominal,

Real and Effective exchange rate, Forward rate, Spot rate, Foreign exchange risks – hedging and speculation- IMF: Functions and International liquidity and Functions of World bank, ADB, and UNCTAD .

**Module IV: Theory of CommercialPolicy** (22 Hours)

Commercial Policy- Free Trade vs Protection- Tariff barriers, Impact of tariff- Optimum Tariff- Non- tariff barriers- quantitative restrictions, General equilibrium analysis- Small and Large country case- Stolper Samuelson theorem- Metzler paradox, Lerner Symmetry theorem.

**References**

1.Salvatore, D (2008) - International Economics, (8th Edition). Wiley India, New Delhi

**Additional Readings**

1. Soderstein B.O and Geffry Reed, (2006 ) International Economics, Palgrave, Mc Milan

2.Krugman P R and Obsfeild M (2009) - International Economics- Theory and Policy, (8th Edition) Pearson, Dorling Kindersley (India) Pvt. Ltd, New Delhi

## MEC 1532: Statistical Methods for Economics II

**4 Credit** **4 hours**

**Course Objective**

The course teaches students the basics of statistical inference. It sets a necessary foundation for the econometrics course. The familiarity with hypothesis testing and research methodology helps to create and conduct an empirical research project in Economics (Primary and Secondary data based research)

**Course Outcomes**

CO 1: Students study the basics of statistical inference.

CO 2: Create and conduct an empirical research project in Economics

CO 3: To understand hypothesis testing and research methodology

CO 4: To acquire thorough understanding of data analysis, statistical tools and research methodology that facilitate transition to higher research programs like M.A/MSc and PhD.

| **MEC 1532: Tagging Course Outcomes** | | | | | |
|---|---|---|---|---|---|
| **CO** | **CO Statement** | **PSO** | **Cognitive Level** | **Knowledge Category** | **Assessment** |
| **CO 1** | To Carry out estimation of standard Parametric and Non-parametric tests used in social science research. | **PSO 3** | Understand | Analyze | Practical questions on one tailed and two tailed tests |

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| **CO 2** | Create and conduct an empirical research project in Economics (Primary and Secondary data based research) probability distributions | **PSO 3** | Understand | Conceptual | Assignment on Steps in carrying out an empirical project |
| **CO 3** | Introduction to Questionnaire Design and Coding | **PSO 3** | Understand | Procedural | Assignment to prepare questionnaire and coding |

**Course Structure**

**Module I: Hypotheses Testing-I**

Null and Alternate Hypotheses; One-tailed and two-tailed Tests; Type I and Type II errors; Power of a Test; Hypothesis testing using p-values;

Parametric Tests : Tests about population mean, proportions and variances (from a single population and from two populations).

**Module II: Hypotheses Testing-II**

Test of Goodness of fit (Poisson and Normal Distribution);Contingency Tables and Chi-square Test of Independence, Nonparametric Tests : Sign Test; Wilcoxon Signed-Rank Test; Mann-Whitney-Wilcoxon Test; Kruskal-Wallis Test; Test for Significant Rank Correlation

**Module III: Research Methodology-I**

Steps in carrying out an empirical project: Posing a research question, Literature Review, Data Collection (Choosing dataset, storing data, cleaning and summarizing data)

**Module VI Research Methodology-II**

Introduction to Secondary Data bases in the Indian Contexts; Introduction to Questionnaire Design, Coding and Types of Data and Scales of Measurement of Variables (Qualitative vs Quantitative Data; Variables measured in Nominal, Ordinal, Interval and Ratio Scale) in

Primary Data based Research. Analysis of data, Writing research report, lay-out of research report.

**Reference**


1. Anderson, D., D.Sweeney and T.Williams (2013): "Statistics for Business and Economics", Cengage Learning : New Delhi.


**Additional Readings**


2. Bryman A (2004) Social Research Methods. Oxford: Oxford University Press
3. Neuman, (2014), Social Research Methods : Qualitative and Quantitative Approaches, Pearson. Devore, J.L. (2010), Probability and Statistics for Engineers, Cengage Learning.
4. Nagar, A.L. and R.K. Das (1993), Basic Statistics, Oxford University Press, New Delhi.
5. Freund, J.E. : "Mathematical Statistics", (Latest Edition), Prentice Hall : India.
6. Yates, Frank(1971), Sampling Methods for Census and Surveys, Charles, Griffin Co.

# Semester VI

## MEC 1631: Basic Econometrics

**7 Hours** **4 Credits**

**Course Outcome**

**CO1-** To provide an understanding of Econometrics

**CO2-** To equip students with knowledge required for the estimation ofsimple linear regression model and providing a basic idea about the multiple regression model.

**CO3-** Toenable them to understand the violations of classical assumptions.

| **MEC 1631: Tagging Course Outcomes** | | | | | |
|---|---|---|---|---|---|
| **Course Outcome** | **CO Statement** | **PSO** | **Cognitive Level** | **Knowledge Category** | **Assessment** |
| **CO 1** | By providing an understanding of the fundamental concepts necessary for the study of econometrics. | **PSO 3** | Understand | Conceptual | An assignment on the Methodology of Econometrics. |
| **CO 2** | By familiarisingthe OLS method and the properties of estimators using the Gauss Markov Theorem. | **PSO 3** | Analyze | Procedural | An assignment on estimating parameters from an appropriate problem |

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|---|---|---|---|---|---|
| **CO 3** | By analysing the basic violations of classical assumptions and their Consequences, Detection and Remedies | **PSO 3** | Analyze | Procedural | An assignment on examining the consequences, detection and remedies for Heteroscedasticity |

**COURSE STRUCTURE**

**Module I: Nature and Scope of Econometrics (15 Hours)**

What is Econometrics? –Methodology of Econometrics – Regression- Modern interpretation of regression- statistical versus deterministic relationships – Regression versus Correlation – simple and multiple regression analysis- Structure of Economic data- Cross Sectional, Time Series, Pooled Cross Sectional and Panel Data.

**MODULE II: Two Variable Regression Analysis: Some Basic Ideas (15 Hours)**

The concept of Population Regression Function (PRF)- Stochastic specification of PRF- Significance of the stochastic disturbance term- The Sample Regression Function (SRF)

**MODULE III: Simple Linear Regression Model: Two Variable Cases (20 Hours)**

Estimation of model by method of ordinary least squares—Properties of estimators—Classical Linear Regression Model: The Assumptions Underlying the method of Least Squares--Gauss Markov theorem—Goodness of fit—Interval estimation—Confidence intervals for Regression—Hypothesis testing—Prediction- Computer exercises

**MODULE IV: Violations of Classical Assumptions (20 Hours)**

Violations of classical assumptions: Consequences, Detection and Remedies—Multicollinearity—Heteroscedasticity—Auto Correlation - specification bias

**Note : This course recommends the use of Spread sheet or Gretl (a free software useful for econometric analysis) for practical exercises.**

**Basic Reading List**

1. D.N.Gujarati and Sangeetha, Basic Econometrics, 4$^{th}$Edition, McGraw Hill Publishing Company Ltd, New Delhi.

2. JeffreyM Wooldridge, Introductory Econometrics, 2nd Edition.

## MEC 1632: Indian Economy

**7 Hours** **4 Credits**

**Course Objective**

The course intends to provide an understanding about growth process in Indian economy, sectoral aspects of the economy by focusing agriculture, industry and service sectors, relations of India with external sector and economic reforms.

**Course Outcomes**

CO 1 – To enable students to understand the growth process of Indian economy by giving a clear idea on the demographic features, trend of urbanisation, poverty and unemployment.

CO 2- To provide general understanding on the land reforms in India and the sectoral aspects of the economy by focusing agriculture and industry.

CO3- To create a general awareness among the students on the scenario of service sector in India with special focus international trade.

CO 4- To familiarise students about the reforms in India since 1991.

| **MEC 1632:Tagging Course Outcomes** | | | | | |
|---|---|---|---|---|---|
| CO | **CO Statement** | **PSO** | **Cognitive Level** | **Knowledge Category** | **Assessment** |
| **CO 1** | By enabling the students to understand the growth process of Indian economy by giving a clear idea on the demographic features, trend of urbanisation, poverty and unemployment. | PSO 5 | Analysis | Procedural | An assignment on portraying various stages of demographic transition in India and subsequent changes in the growth of urbanization, poverty |

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|---|---|---|---|---|---|
| | | | | | and unemployment level in India |
| **CO 2** | By providing general understanding on the land reforms in India and the sectoral aspects of the economy by focusing agriculture and industry. | PSO 5 | Analysis | Procedural | An analysis on the impact of land reforms on the growth of agriculture and industrial contribution in GDP |
| **CO3** | By creating a general awareness among the students on the scenario of service sector in India with special focus international trade. | PSO 5 | Evaluate | Procedural | Assignment based on RBI: Handbook of Statistics on Indian economy<br>**(Link:https://www.rbi.org.in/scripts/AnnualPublications.aspx?head=Handbook%20of%20Statistics%20on%20Indian%20Economy )** |
| **CO4** | By familiarising students about the reforms in India since 1991. | PSO 1 | Evaluate | Procedural | An evaluation of fiscal, financial and external sector reforms in India. |

**COURSE STRUCTURE**

**Module 1: Growth process in Indian Economy** **25 hrs**

Indian economy since independence: Growth trends- National Income, Savings & investments, Demographic features – demographic transition and India, optimum population, health indicators, literacy status, demographic dividend, Urbanization – trends and issues, rural urban migration, Poverty –poverty line, rural & urban poverty, measures and programs. Inequality – features, various indices-Employment and Unemployment – trends, types, measures and programs, inflation – trends, reasons and measures.

**Module 2: Agriculture and Industry since independence** **20hrs**

Agriculture sector – land use and cropping pattern-Strategies relating to technologies and institutions: food security, land relations and land reforms, agriculture credit, modern farm

inputs and marketing - price policy and subsidies; commercialisation and diversification, New Agriculture policy.

Industry - Strategy of industrial development - Core industries -growth of MSMEs- sources of industrial finances (banks, share market, insurance companies, pension funds, non-banking sources, MUDRA loan)-labour market-formal and informal- labour laws in India

**Module 3: Service Sector and international trade 20hrs**

Services sector - Importance and composition, banking, insurance, transport and communication, education and health, public administration and defence, e-commerce-performance of public sector enterprises

India's foreign trade – volume, direction and composition- balance of payments-exchange rate management- Role of international oil and gold prices in Indian economy

**Module 4: Indian Economic Reforms since 1991 15hrs**

Fiscal, financial and external sector reforms-Agriculture and industrial sector reforms- planning and economic growth-shifts in planning approach- NITI Ayog- Global financial crisis and Indian economy-Impacts of GST and demonetization- Impact of Digital economy.

**Note: Students have to visit an industrial unit, study some of the economic aspects and submit a report**

**References**

**Module1**

Jean Dreze and Amartya Sen, 2013, India: An Uncertain Glory, Oxford University Press

Pulapre Balakrishnan, 2007, "The Recovery of India: Economic Growth in the Nehru Era", Economic and Political Weekly, November

Arvind Subramanian, 2012,"Growth Experience" in K Basu and A Maertens, The New Oxford Companion to Economics, Oxford University Press.

NilanjanBanik, "The Indian Economy: A Macroeconomic Perspective", Sage Publications

Chetan Ghate, The Oxford Handbook of Indian Economy", Oxford University Press

Mihir Rakshit(2011)Inflation and Relative Prices in India 2006-10: Some Analytical and Policy IssuesEconomic& Political Weekly EPW april 16, 2011 vol xlvi no 16

Vinoj Abraham (2017)Stagnant Employment Growth Last Three Years May Have Been the WorstVo.52, Issue No.38,23 Sep 2017, EPW

**Module 2**

Hanumantha Rao, Bhattacharya &Siddarthan, ed.(2005)Indian Economy and society in the Era of Globalisation and liberalisation

Chandrasekhar Rao and Mahendra Dev, 2010, Agricultural Price Policy, Farm Profitability and Food Security, EPW, June 26

JeemolUnni (2015) Employment and Industrial Development in India , in C P Chandrasekhar(ed) Economics Vol 1. Indian Industrialsiation

Jayati Ghosh (2008) The Indian Economy 1970-2003 pp1027-1045 Dharma Kumar(ed) The Camebridge Economic History of India with a new introduction by in Sabyascahi Bhattacharya. Orient Blackswan

Vaidyanathan (2008) The Indian Economy since independence pp945-994 Dharma Kumar(ed) The Camebridge Economic History of India with a new introduction by in SabyascahiBhattacharya,OrientBlackswan

**Module 3**

Rupa Chanda, 2012, Services Led Growth in New Oxford Companion to Economics

K Kanagasabapathy, Vishakha G Tilak, and R Krishnaswamy, 2013, A Rethink on India's Foreign Trade Policy, EPW August 3.

Biswajit Dhar 2015, India's New Foreign Trade Policy, EPW, May 24.

Jean Dreze and Amartya Sen, 2013, India: An Uncertain Glory, Oxford University Press

NilanjanBanik, "The Indian Economy: A Macroeconomic Perspective", Sage Publications.-

J.B.J. Tilak (2014) Private Higher Education in India, Vol.49, Issue No.40, 04 Oct, 2014, EPW

**Module 4**

25 Years Of Economic Liberalisation, Vol. 52, Issue No. 2, 14 Jan, 2017, EPW

Nagaraj, R(2013) Understanding the Boom and Its Aftermath: India's Dream Run Vol. 48, Issue No. 20, 18 May, 2013 http://www.epw.in/journal/2013/20/special-articles/indias-dream-run-2003-08.html

Mihir Rakshit (2018) Some Analytics of Demonetisation, MARCH 31, 2018 No.13 EPW

Kaushik Basu and AnnemieMaertens(2010)The Concise Oxford Companion to Economics in India, Oxford

Mihir Rakshit (2011) Macro economics of Post-reform India, OUP

https://cleartax.in/s/gst-analysis-and-opinions

Atul Sood (2017) The New Moral Economy- Demonetisation, Digitalisation and India's Core Economic Problems, Vo.52, Issue No.1, 07, Jan 2017, EPW

Economic Survey, GOI, various years

www.mospi.nic.in

www.censusindia.gov.in

# MEC 1533: PROJECT WORK

**No of Credits -3**

**Total Hours - 3**

**(Semester V)**

## Guidelines

1) Students should (Group wise/ Single) strictly present the topic before the faculty for approving their project proposal. This should be carried out in the 5th semester.
2) One day orientation class on research methodology by an eminent resource person should be arranged for developing exposure in research work among students before starting the project work.
3) A pre submission seminar should be undertaken at the 5th semester for reviewing the nature and quality of the project work.

## Specification of the Project Work

1. The Project Work may be any economic problem relevant to the study of Economics.
2. It should be based on either primary or secondary source of data.
3. It should be a typed one of 25-40 pages (spiral bind)
4. The Project Work shall contain the following items.
   A. Introduction and Review of literature.
   B. Methodology
   C. Analysis
   D. Conclusion & Suggestion if any
   E. Bibliography
5. The Project Assignment may be given in the 4th semester and report should be submitted at the end of 5th semester.
6. An acknowledgment, declaration certificate of the supervising teacher etc should also be attached.

**Evaluation Indicators**

| Project Report Indicators | Score | Weightage |
|---|---|---|
| 1. Introduction and Review of literature | | 10% |
| 2. Methodology | | 20% |
| 3. Analysis | | 40% |
| 4. Conclusion & Suggestion | | 20% |
| 5. Bibliography | | 10% |

## SYLLABUS OF CORE COURSE-II (MATHEMATICS)

## SEMESTER-I

## INFORMATICS

**(Foundation Course-I)**

**Code: MEC 1121** **Instructional hours per week: 2**

**No.of credits: 2**

**Course Outcomes: At the end of the Course ,the Student will be able to-**

**CO 1: To introduce various online resources which will help students improve their teaching-learning experience.**

**CO 2: The students will also be able to utilize these web resources to enhance their career and academics.**

**CO 3: To provide awareness on Internet and E-Commerce.**

**MODULE I: Introduction (10 Hours)**

Informatics: Meaning and Scope, Information Networks- INFLIBNET, NICNET. E-Books, Audio Books, Blogs, Podcasts, Massive Open Online Courses (MOOCs); Statistical Software for social science Research (Features of SPSS, E-Views, Gretl and R software)

**MODULE: II: Data analysis (10 Hours)**

Spread sheet basics. Excel environment. Entering data. Excel tool bars. Analysis of data using Spread sheets - Creation and manipulation of charts and graphs. Manipulation of data. Importing and exporting data from excel. Mathematical and statistical calculations.Excel functions. Applications in economics using simple examples.

**MODULE: III: The internet and E-Commerce**. **(16Hours)**

Meaning and scope of the internet, Search techniques, search engines – browsers. Online shopping and e-business / e-commerce (concepts) - Challenges with internet security – malware, phishing Computer virus, Antivirus software and privacy.

**Reference**


- Peter Norton, Introduction to Computers,McGrawHill N. Delhi.
- PK Sinha, Computer Fundamentals, BPB Publications
- ReemaThareja, Fundamentals of Computers. Oxford.
- RamezElmasri and Shamkant B Navathe,Fundementals of data base Systems, Pearson
- V Rajaraman, Fundamentals of Computers, PHI publications
- Online resources (Tutorials on Excel)
- https://www.coursera.org/
- https://www.edx.org/
- https://www.swayam.gov.in
- http://www.learnerstv.com/
- http://www.inflibnet.ac.in
- http://www.bbc.co.uk/podcasts

## FOUNDATIONS OF MATHEMATICS

**Code: MEC 1141** **Instructional hours per week:3**

**No. of credits :3**

**Course Outcomes : At the end of the Course ,the Student will be able to-**

**CO-1. Understand the derivative of a function.**
**CO-2. Learn certain theorems on differentiation.**
**CO-3. Learn various applications also the physical interpretations of differentiation (derivative of a function).**
**CO-4. Understand the integration of a function and learn its physical interpretation through various examples.**
**CO-5. Learn various applications of integration.**

**Module I** - Methods of Differential Calculus (18 Hours)

Differentiating equations to relate rates, how derivatives can be used to approximate non-linear functions by linear functions, error in local linear approximation, differentials; Increasing and decreasing functions and their analysis, concavity of functions, points of inflections of a function and applications, finding relative maxima and minima of functions and graphing them, critical points, first and second derivative tests, multiplicity of roots and its geometrical interpretation, rational functions and their asymptotes, tangents and cusps on graphs; Motion along a line, velocity and speed, acceleration, Position - time curve, Rolle's, Mean Value theorems and their consequences; Indeterminate forms and L'Hôpital's rule;

The topics to be discussed in this module can be found in chapter 2,3 and 6 of text [1] below.

**Module II** - Methods of Integral Calculus (36 Hours)

Finding position, velocity, displacement, distance travelled of a particle by integration, analysing the distance-velocity curve, position and velocity when the acceleration is constant, analysing the free- fall motion of an object, finding average value of a function and its applications; Area, volume, length related concepts : Finding area between two curves, finding volumes of some three dimensional solids by various methods like slicing, disks and washers, cylindrical shells, finding length of a plane curve, surface of revolution and its area; Work done : Work done by a constant force and a variable force, relationship between work and energy; Relation between density and mass of objects, center of gravity, Pappus theorem and related problems Fluids, their density and pressure, fluid force on a vertical surface. Introduction to Hyperbolic functions and their applications in hanging cables; Improper integrals, their evaluation, applications such as finding arc length and area of surface.

The topics to be discussed in this module can be found in chapter 4, 5, 6 and 7 of text [1] below.

**Texts**

**Text-1 – H Anton, I Bivens, S Davis. Calculus, 10th Edition, John Wiley& Sons,2012.**

***References***

**Ref. 1 – G B Thomas, R L Finney. Calculus, 9th Edition, Addison-Weseley Publishing Company**

**Ref. 2 – J Stewart. Calculus with Early Transcendental Functions, 7th Edition, Cengage India, Private Limited**

# THEORY OF NUMBERS

**Code: MEC 1142** **Instructional hours per week: 3**

**No. of credits: 3**

**Course Outcomes : At the end of the Course ,the Student will be able to-**

**CO-1.Become familiar with various kinds of numbers.**
**CO-2.Understand the role of numbers in other branches of Mathematics, in particular Combinatorics, Set Theory and Algebra.**
**CO-3.Analyze different characters of number theoretic functions.**
**CO-4.Use number theoretical properties to solve real world problems.**
**CO-5.Applications of number theoretical concepts in various field and in particular Cryptography.**

**Module I** - Divisibility in integers (24 Hours)

The topic of elementary number theory is introduced for further developing the ideas in abstract algebra. The following are the main topics in this module : The division algorithm, Pigeonhole principle, divisibility relations, inclusion-exclusion principle, base-b representations of natural numbers, prime and composite numbers, infinitude of primes, GCD, linear combination of integers, pairwise relatively prime integers, the Euclidean algorithm for finding GCD, the fundamental theorem of arithmetic, canonical decomposition of an integer into prime factors, LCM; Linear Diophantine Equations and existence of solutions, Euler's Method for solving LDE's

The topics to be discussed in this module can be found in chapter 2 (except the topics the Egyptian method of multiplication, the Russian Peasant Algorithm & Egyptian method of division in Section 2.2, Section 2.3 and 2.4, A Number - Theoretic Function onwards in Section 2.5 , Section 2.6 and 2.7 )and chapter 3(except the topic A jigsaw puzzle onwards in Section 3.2 , Factor Tree onwards in Section 3.3, The Monkey and Coconuts Puzzle on wards in Section 3.5 )of text [1] below.

**Module II** - Congruence relations in integers (30 Hours)

Towards defining the congruence classes in Z, we begin with defining the congruence relation. Its various properties should be discussed, and then the result that no prime of the form 4n + 3 is a sum of two squares should be discussed. The other topics in this module are the following: Defining congruence classes, complete set of residues, modulus exponentiation, finding reminder of big numbers using modular arithmetic, cancellation laws in modular arithmetic, linear congruences and existence of solutions, solving Mahavira's puzzle, modular inverses, Pollard Rho factoring method;

Certain tests for divisibility - The numbers here to test are powers of 2, 3, 5, 7, 9, 10, 11, testing

whether a given number is a square;Linear system of congruence equations, Chinese Remainder Theorem and some applications; Some classical results like Wilson's theorem, Fermat's little theorem, Pollard $p-1$ factoring method, Eulers' theorem, The topics to be discussed in this module can be found in chapter 2 and 3 of text [1] below.

**Texts**

**Text -**1– **Thomas Koshy. Elementary Number Theory with Applications, 2nd Edition, Academic Press,2007.**

***References***

**Ref. – G .A. Jones, J .M. Jones. Elementary Number Theory, Springer,2005.**

## SEMESTER-II

## DIFFERENTIAL EQUATIONS

**CODE: MEC 1241** **Instructional hours per week: 3**
**No. of credits: 3**

**Course Outcomes: At the end of the Course ,the Student will be able to-**

**CO-1.Learn various methods to solve first order linear differential equations.**
**CO-2.Learn the existence and uniqueness theorem of first order ordinary differential equation.**
**CO-3.Learn various methods to solve certain nonhomogeneous second order ordinary differential equations with constant coefficients.**
**CO-4.Learn the applications of ordinary differential equations.**

In this course, we discuss how differential equations arise in various physical problems and consider some methods to solve first order differential equations and second order linear equations. For introducing the concepts, text [1] may be used, and for strengthening the theoretical aspects, reference [1] may be used.

**Module I - First order ODE** (24 hours)

In this module we discuss first order equations and various methods to solve them. Suffi- cient number of exercises also should be done for understanding the concepts thoroughly. The main topics in this module are the following:
Modelling a problem, basic concept of a differential equation, its solution, initial value problems, geometric meaning (direction fields), seperable ODE, reduction to seperable form, exact ODEs and integrating factors, reducing to exact form, homogeneous and non homogeneous linear ODEs, special equations like Bernoulli equation, orthogonal trajecto- ries, understanding the existence and uniqueness of solutions theorem.

*The topics to be discussed in this module can be found in chapter 1 of* text [1] *below.*

**Module II - Second order ODE** (30 hours)

As in the first module, we discuss second order equations and various methods to solve them. Sufficient number of exercises also should be done for understanding the concepts thoroughly. The main topics in this module are the following:
homogeneous linear ODE of second order, initial value problem, basis, and general solu- tions, finding a basis when one solution is known, homogeneous linear ODE with constant coefficients (various cases that arise depending on the characteristic equation), differential operators, Euler-Cauchy Equations, existence and uniqueness of solutions w.r. to wron- skian, solving nonhomogeneous ODE via the method of undetermined coefficients, varius applications of techniques, solution by variation of parameters.

*The topics to be discussed in this module can be found in chapter 2 of* text [1] *below.*

**Texts**

**Text-1** – Erwin Kreyszig. *Advanced Engineering Mathematics*, 10th Edition, Wiley-India,2011.

***References***

Ref. 1 – G. F. Simmons. *Differential Equations with applications and Historical notes*, Tata McGraw-Hill, 2003

Ref. 2 – H Anton, I Bivens, S Davis. *Calculus*, 10th Edition, John Wiley & Sons,2012.

Ref. 3 – Peter V. O'Neil. *Advanced Engineering Mathematics*, Thompson Publications, 2007.

# VECTOR CALCULUS

**Code:MEC 1242** **Instructional hours per week: 4**

**No.of credits: 4**

**Course Outcomes : At the end of the Course , the Student will be able to-**

**CO-1.Understand vectors and algebraic operations of vectors.**
**CO-2.Learn to compute the vector equation of a line.**
**CO-3.Understand the cylindrical and spherical coordinate systems.**
**CO-4.Learn calculus of vector valued functions.**
**CO-5.Understand the geometrical interpretation of Curvature and motion of a particle along a Curve through Calculus of Vectors.**

**Module I** – Introduction to vector calculus (36 Hours)

To begin with, the three dimesional rectangular co-ordinate system should be discussed and how distance is to be calculated between points in this sytem. Basic operations on vectors like their addition, cross and dot products should be introduced next. The concept of projections of vectors and the relation with dot product should be given emphasize. Equations of lines determined by a point and vector, vector equations in lines, equatins of planes using vectors normal to be should be discussed. Quadric surfaces which are three dimensinal analogues of conics should be discussed next. Various co-ordinate systems like cylindrical, spherical should be discussed next with the methods for conversion between various co-ordinate systems. The topics to be discussed in this module can be found in chapter 11 of text [1] below.

**Module II** - Vector valued functions (36 Hours)

Towards going to the calculus of vector valued functions, we define such functions. The other topics in this module are the following : Parametric curves in the three dimensional space, limits, continuity and derivatives of vector valued functions, geometric interpretation of the derivative, basic rules of differentiation of such functions, derivatives of vector products, integrating vector functions, length of an arc of a parametric curve, change of parameter, arc length parametrizations,

various types of vectors that can be associated to a curve such as unit vectors, tangent vectors, binormal vectors, definition and various formulae for curvature, the geometrical interpretation of curvature, motion of a particle along a curve and geometrical interpreta tion of various vectors associated to it, various laws in astronomy like Kepler's laws and problems The topics to be discussed in this module can be found in chapter 12 of text [1] below.

**Texts**

**Text -1– H Anton, I Bivens, S Davis. Calculus, 10th Edition, John Wiley & Sons,2012.**

***References***

**Ref. 1 – G B Thomas, R L Finney. Calculus, 9th Edition, Addison-Weseley Publishing Company**

**Ref. 2 – J Stewart. Calculus with Early Transcendental Functions, 7th Edition, Cengage India Private Limited**

## SEMESTER- III

## MULTI VARIABLE CALCULUS AND VECTOR CALCULUS

**Code: MEC 1341** **Instructional hours per week: 5**

**No.of credits: 3**

**Course Outcomes: At the end of the Course ,the Student will be able to-**

**CO-1.Learn about functions of more than one variable.**
**CO-2.Understand the limit, continuity and differentiability of functions with more than one variable.**
**CO-3.Understand various applications of multivariable calculus.**
**CO-4.Learn the integration of vector valued function.**
**CO-5.Learn various applications of integration of vector valued functions.**

**Module I**- Multivariable Calculus (45 Hours)

After introducing the concept of functins of more than one variable, the sketching of them in three dimensinal cases with the help of level curves should be discussed. Countours and level surface plotting also should be discussed. The other topics in this module are the following: Limits and continuity of Multivariable functions, various results related to finding the limits and establishing continuity, continuity at boundary points, partial derivatives of functions, partial derivative as a function, its geometrical interpretation, implicit partial differentiation, changing the order of partial differentiation and the equality conditions; Differentiability of a multivariate function, differentiability of such a function implies its continuity, local linear approximations, chain rules - various versions, directional derivative and differentiability, gradient and its properties, applications of gradients; Tangent planes and normal vectors to level surfaces, finding tangent lines to intersec tions of surfaces, extrema of multivariate functions, techniques to find them, critical and saddle points, Lagrange multipliers to solve extremum problems with constrains, The topics to be discussed in this module can be found in chapter 13 of text [1] below.

**Module II** - Vector Calculus (45 Hours)

After the differentiation of vector valued functions in the last semester, here we introduce the concept of integrating vector valued functions. Some important theorems are also to be discussed here. The main topics are the following : Vector fields and their graphical representation, various type of vector fields (inverse- square, gradient, conservative),

potential functions, divergence, curl, the 5 operator, Laplacian; Integrating a function along a curve (line integrals), integrating a vector field along a curve, defining work done as a line integral, line integrals along piecewise-smooth curves, integration of vector fields and independence of path, fundamental theorem of line integrals, line integrals along closed paths, test for conservative vector fields, Green's theorem and applications; Defining and evaluating surface integrals, their applications, orientation of surfaces, evaluating flux integrals, The divergence theorem, Gauss' Law, Stoke's theorem, applications of these theorems. The topics to be discussed in this module can be found in chapter 15 of text [1] below.

**Texts**

**Text -1 – H Anton, I Bivens, S Davis. Calculus, 10th Edition, John Wiley & Sons,2012.**

***References***

**Ref. 1 – G B Thomas, R L Finney. Calculus, 9th Edition, Addison-Weseley Publishing Company**

**Ref. 2 – J Stewart. Calculus with Early Transcendental Functions, 7th Edition, Cengage India Private Limited.**

## ABSTRACT ALGEBRA – GROUP THEORY

**CODE: MEC 1342** **Instructional hours per week: 5**
**No.of credits: 4**

**Course Outcomes : At the end of the Course,the Student will be able to-**

**CO-1.Understand the definition of group and its various properties through examples.**
**CO-2.Understand subgroups, cyclic groups and various properties of the same.**
**CO-3.One will be able to understand permutation groups.**
**CO-4.Learn the well-known Cayley's and Lagrange's theorem.**
**CO-5.Learn certain applications of group theory.**

The aim of this course is to provide a very strong foundation in the theory of groups. All the concepts appearing in the course are to be supported by numerous examples mainly from the references provided.

**Module I** (30 Hours)

The concept of group is to be introduced before rigorously defining it. The symmetries of a square can be a starting point for this. After that, definition of group should be stated and should be clarified with the help of examples. After discussing various properties of groups, finite groups and their examples should be discussed. The concept of subgroups with various characterizations also should be discussed. After introducing the definition of cyclic groups, various examples, and important features of cyclic groups and results on order of elements in such groups should be discussed.
*The topics to be discussed in this module can be found in chapter 1, 2 3 and 4 of* text [1]

*below.*

**Module II** (24 Hours)

This module starts with defining and analysing various properties permutation groups which forms one of the most important class of examples for non abelian, finite groups. After defining operations on permutations, their properties are to be discussed. To moti- vate the students, the example of check-digit scheme should be discussed (This section on check-digit scheme is not meant for the examinations). Then we proceed to define the no- tion of equivalence of groups viz. isomorphisms. Several examples are to be discussed for explaining this notion. The properties of isomorphisms are also to be discussed together with special classes of isomorphisms like automorphisms and inner automorphisms before finishing the module with the classic result of Cayley on finite groups.
*The topics to be discussed in this module can be found in chapter 5 and 6 of* text [1] *below.*

**Module III** (18 Hours)

In this module we prove one of the most important results in group theory which is the Langrange's theorem on counting cosets of a finite group. The concept of cosets

of a group should be defined giving many examples before proving the Lagrange's theorem. As some of the applications of this theorem, the connection between permutation groups and rotations of cube and soccer ball should be discussed. The section on Rubik's cube and section on internal direct products need not be discussed.

*The topics to be discussed in this module can be found in chapter 7 and 9 of* text [1] *below.*

**Module IV** (18 hours)

Here the concept of group homomorphisms should be defined with sufficient number of examples. After proving the first isomorphism theorem, the fundamental theorem of iso- morphism should be introduced **without proof**. Classifying groups based on the fundamental theorem should be discussed in detail.

*The topics to be discussed in this module can be found in chapter 10 and 11 of* text [1] *below.*

**Texts**

**Text** -1 – **Joseph Gallian.** ***Contemporary Abstract Algebra*****, 8th Edition, Cengage Learning,2013.**

***References***

**Ref. 1 – D .S. Dummit, R M Foote.** ***Abstract Algebra*****, 3rd Edition, Wiley .**

**Ref. 2 – I. N. Herstein.** ***Topics in Algebra*****, Vikas Publications**

**SEMESTER-IV**

## ABSTRACT ALGEBRA – RING THEORY

**CODE: MEC 1441** **Instructional hours per week: 5**
**No.of credits: 4**

**Course Outcomes : At the end of the Course ,the Student will be able to-**

**CO-1.Understand the definition, various properties ofrings through examples.**
**CO-2.Understand the definition and various properties of prime ideal and maximal ideal.**
**CO-3.Understand the definition of ring homomorphism and various properties of the same.**
**CO-4.Learn polynomial rings, reducibility, irreducibility and the unique factorization of some.polynomial rings.**
**CO-5.Learn divisibility properties of various integral domains.**
**CO-6.Learn unique factorization domains and Euclidean domains through examples.**

After discussing the theory of groups thoroughly in the previous semester, we move towards the next higher algebraic structure rings. As in the last semester, all the new concepts appearing in the course is to be supported by numerous examples mainly from the references provided.

**Module I** (30 Hours)

The concept of rings, subrings with many examples should be discussed here. Next comes the definition and properties of integral domains, fields, and the characteristic of rings. Ideals, how factor rings are defined using ideals, should be explained next. The definition of prime and maximal ideals with examples should be discused after that.

*The topics to be discussed in this module can be found in chapter 12, 13 and 14 of* text [1] *below.*

**Module II** (30 Hours)

After introducing the definition of ring homomorphisms, their properties should be dis- cussed. The field of quotients of an integral domain should be discussed next. The next topic is the definition and various properties of polynomial rings over a commutative ring. Various results on operations on polynomials such as division algorithm, factor theorem, remainder theorem etc should be discussed next. The definition and examples of PID's should be discussed next, before moving to the factorization of polynomials. Tests of irre- ducibility and reducibility and the unique factorization of polynomials over special rings should be discused.
.

*The topics to be discussed in this module can be found in chapter 15, 16 and 17 of* text [1] *below.*

**Module III** (30 Hours)

In the last module, we introduce more rigorous topics like various type of integral domains. The divisibility properties of integral domains and definition of

primes in a general ring should be introduced. Unique factorization domains and the Euclidean domains should be discussed next with examples. Results on these special integral domains are aslo to be discussed.

*The topics to be discussed in this module can be found in chapter 18 of* text [1] *below.*

**Texts**

**Text** -1 – **Joseph Gallian;** ***Contemporary Abstract Algebra,*** **8th Edition, Cengage Learning,2013.**

***References***

**Ref. 1 – D S Dummit, R M Foote;** ***Abstract Algebra,*** **3rd Edition, Wiley**

**Ref. 2 – I N Herstein,** ***Topics in Algebra,*** **Vikas Publications**

**LINEAR ALGEBRA**

**CODE: MEC 1442** **Instructional hours per week: 5**

**No.of credits: 3**

**Course Outcomes : At the end of the Course , the Student will be able to-**

**CO-1.Learn the Gauss Elimination method also one will be able to find inverse of matrices by the elimination method.**

**CO-2.One will be able to solve a non-homogeneous linear system of equations.**

**CO-3.Understand the basis and dimension of a Vector space.**

**CO-4.Learn linear transformation on a vector space through certain examples.**

**CO-5.Understand the Eigen values of a matrix.**

**CO-6.Learn the diagonalization of a matrix.**

The main focus of this course is to introduce linear algebra and methods in it for solving practical problems.

**Module-I** (25 Hours)

This module deals with a study on linear equations and their geometry. After introducing the geometrical intrepretation of linear equations, following topics should be discussed: various operations on column vectors, technique of Gaussian elimination, operations in- volving elementary matrices, interchanging of rows using elementary matrices, triangular factorisation of matrices and finding inverse of matrices by the elimination method.

*The topics to be discussed in this module can be found in chapter 1 of* text [1] *below. The section 1.7 may be omitted.*

**Module-II** (30 hours)

Towards the study of vector spaces, specifically $R^n$, we define them with many examples. Subspaces are to be defined next. After discussing the idea of nullspace of a matrix. The solving linear equations (which was one to some extent in the first module) and finding solutions to non-homogeneous systems from the corresponding homogeneous systems. Af- ter this, linear independence and dependence of vectors, their spanning, basis for a space, its dimension concepts are to be introduced. The column, row, null, left null spaces of a matrix is to be discussed next. When inverses of a matrix exists related to its column/row rank should be discussed. Towards the end of this module, linear transformations (through matrices) and their properties are to be discussed. Types of transformations like rotations, projections, reflections are to be considered next.

*The topics to be discussed in this module can be found in chapter 2 of* text [1] *below. The section 2.7 on graphs and networks may be omitted.*

**Module-III** (35 hours)

This module is intended for making the idea and concepts of determinants stronger. Its properties like what happens when rows are interchanged, linearlity of expansion along the first row, etc are to be discussed. Breaking a matrix into triangular, diagonal forms and finding the determinants, expansion in cofactors, their applications like solving system of equations, finding volume etc are to be discussed next.

We conclude our analysis of matrices. The problem of finding eigen values a matrix is to be introduced first. Next goal is to diagonalize a matrix. This concept should be discussed first, and move to the discussion on the use of eigen vectors in diagonalization.

*The topics to be discussed in this module can be found in chapter 4 and 5 of* text [1] *below.*

**Texts**

**Text -1 – Gilbert Strang, *Linear Algebra and Its Applications*, 4th Edition, Cengage Learning.**

***References***

**Ref. 1 – *Video lectures of Gilber Strang Hosted by MITOpenCourseware* available at https://ocw.mit.edu/courses/mathematics/18-06-linear-algebra-spring-2010/ video-lectures/**

**Ref. 2 – Thomas Banchoff, John Wermer; *Linear Algebra Through Geometry*, 2nd Edi- tion, Springer**

**Ref. 3 – T S Blyth, E F Robertson: *Linear Algebra*, Springer, Second Edition. Ref. 4 – David C Lay: *Linear Algebra*, Pearson**

**Ref. 5 – K Hoffman and R Kunze: *Linear Algebra*, PHI.**

## SEMESTER-V

### REAL ANALYSIS – I

**CODE: MEC 1541** **Instructional hours per week:6**
**No.of credits:4**

**Course Outcomes: At the end of the Course ,the Student will be able to-**

**CO-1.Understand sequence and series of real numbers.**

**CO-2.Learn the existence of an irrational number in R, completeness property of R, density of rational numbers on R.**

**CO-3.Learn uncountability and various cardinality results on R.**

**CO-4.Learn the convergence of sequences and series of real numbers.**

**CO-5.Learn certain important theorems namely the Bolzano - Weierstrass theorem, the Cauchy criterion for convergence of a sequence and the Monotone convergence theorem.**

In this course, we discuss the notion of real numbers, the ideas of sequence of real numbers and the concept of infinite summation in a formal manner. Many of the topics discussed in the first two modules of this course were introduced somewhat informally in earlier courses, but in this course, the emphasis is on mathematical rigor. A minimal introduction to the metric space structure of R is also included so as to serve as a step- ping stone into the idea of abstract topological spaces. The course is mainly based on Chapters 1–3 of text [1].
All the chapters mentioned above contains a section titled *Discussions* in the beginning of the chapter. This section is intended only for motivating the students, and so should not be made as a part of the examination process.

**Module-I** (36 Hours)

This module introduces the basic concepts about the real number system with some in- troduction to sets, functions, and proof techniques. The following are the main topics to be discussed: existence of an irrational number, the axiom of completeness, upper lower bounds of sets in R, consequences of completeness like Archimedian property of real num- bers, Density of Q in R, existence of square roots, countability of Q and uncountability of R, various cardinality results, Cantor's original proof for uncoubtability of R, and Cantor's theorem on power sets.

*The topics to be discussed in this module can be found in chapter 1 of* text [1] *below. The first section 1.1 may be briefly discussed and is not meant for examination purposes.*

**Module-II** (40 hours)

Students must have already encountered the idea of infinite series through the example of geometric progression. After discussing the rearrangement concept of infinite series, the following topics are to be introduced rigourously : Limit of a sequence, diverging se- quences, examples, algebraic operations on limits, and order properties of sequences and limits, the Monotone Convergence Theorem, Cauchy's condensation test for convergence of a series, various other tests for the convergence series, the Bolzano-Weierstrass theorem, the Cauchy criterion for convergence of a sequence, rearrangement of absolutely convergent series.

*The topics to be discussed in this module can be found in chapter 2 of* text [1] *below. The first section 2.1 may be briefly discussed and is not meant for examination purposes.*

**Module-III** (32 Hours)

This module is intended to be a beginner for learning abstract metric spaces. To motivate the students, the Cantor set should be constructed and shown in the beginning. Then move to the topics open and closed sets in **R**, and what about

their completeness, Compactness of sets (defined using sequential convergence), open covers and compactness.

*The topics to be discussed in this module can be found in chapter 3 of text [1] below. The*

*first section 3.1 may be briefly discussed and is not meant for examination purposes. The sections 3.4 and 3.5 need not be discussed.*

**Texts**

**Text -1 – Stephen Abbot. *Understanding Analysis*, 2nd Edition, Springer,2015**

***References***

**Ref. 1 – R G Bartle, D Sherbert. *Introduction to Real Analysis*, 3rd Edition, John Wiley & Sons**

**Ref. 2 – W. Rudin. *Principles of Mathematical Analysis*, Second Edition, McGraw-Hill**

**Ref. 3 – Terrence Tao. *Analysis I*, Hindustan Book Agency**

## COMPLEX ANALYSIS – I

**CODE: MEC 1542** **Instructional hours per week: 5**
**No. of credits: 4**

**Course Outcomes : At the end of the Course ,the Student will be able to-**

**CO-1.Understand the algebra of Complex numbers.**
**CO-2.Learn how to find the polar form of a complex number.**
**CO-3.Understand the limit, continuity and analyticity of Complex function.**
**CO-4.Learn Cauchy Riemann equations and Harmonic functions.**
**CO-5.Learn about certain elementary complex functions.**
**CO-6.Learn Contour integration of complex valued functions.**

Here we go through the basic complex function theory.

**Module-I** (35 Hours)

Complex numbers : The algebra of Complex Numbers, Point Representation of Complex Numbers, Vectors and Polar forms, The Complex Exponential, Powers and Roots, Planar Sets
Analytic Functions : Functions of a complex variable, Limits and Continuity, Analyticity, The Cauchy Riemann Equations, Harmonic Functions

*The topics to be discussed in this module can be found in chapter 1, sections 1.1, 1.2, 1.3, 1.4, 1.5, 1.6 and chapter 2, sections 2.1, 2.2, 2.3, 2.4, 2.5 of* text [1] *below.*

**Module-II** (25 hours)

Elementary Functions : Polynomials and rational Functions ( Proof of the theorem on par- tial fraction decomposition need not be discussed), The Exponential, Trigonometric and Hyperbolic Functions, The Logarithmic Function, Complex Powers and Inverse Trigono- metric Functions.

*The topics to be discussed in this module can be found in chapter 3, sections 3.1, 3.2, 3.3,of* text [1] *below.*

**Module-III** (30 hours)

Complex Integration : Contours, Contour Integrals, Independence of Path, Cauchy's In- tegral Theorem (Section 4.4a on deformation of Contours Approach is to be discussed, but section 4.4 b on Vector Analysis Approach need not be discussed), Cauchy's Integral Formula and Its Consequences, Bounds of Analytic Functions

*The topics to be discussed in this module can be found in chapter 4, sections 4.1, 4.2, 4.3, 4.4a, 4.5 and 4.6 of* text [1] *below.*

**Texts**

**Text-1 –** Edward B. Saff, Arthur David Snider. *Fundamentals of complex analysis with applications to engineering and science*, 3rd Edition, Pearson Education India.

***References***

**Ref. 1 – John H Mathews, Russel W Howell. *Complex Analysis for Mathematics and Engineering*, Jones and Bartlett Publishers**

**Ref. 2 – Erwin Kreyszig. *Advanced Engineering Mathematics*, 10th Edition, Wiley-India**

**Ref. 3 – James Brown, Ruel Churchill. *Complex Variables and Applications*, Eighth Edition, McGraw-Hill**

**SEMESTER-V**

**OPERATIONS RESEARCH (OPEN COURSE)**

**CODE: MEC1551.1** **Instructional hours per week: 3**
**No. of Credits: 2**

**Course Outcomes**

1. **Identify the characteristics of linear programming problems.**
2. **Formulate linear programming problems.**
3. **Understand various methods for solving linear programming problems.**
4. **Solve transportation problems using different methods.**
5. **Understand basic concepts in project management.**

**Module-I – Linear Programming** (18 hours)
Formulation of Linear Programming models, Graphical solution of Linear Programs in two variables, Linear Programs in standard form - basic variable - basic solution- basic feasi- ble solution -feasible solution, Solution of a Linear Programming problem using simplex method (Since Big-M method is not included in the syllabus, avoid questions in simplex method with constraints of $\geq$ or = type.)

**Module-II – Transportation Problems** (18 hours)
Linear programming formulation - Initial basic feasible solution (Vogel'sapproximation method/North-west corner rule) - degeneracy in basic feasible solution - Modified distri- bution method - optimalitytest.
ASSIGNMENT PROBLEMS: Standard assignment problems - Hungarian method for solv- ing an assignment problem.

**Module-III – Project Management** (18hours)
Activity -dummy activity - event - project network, CPM (solution by network analysis only), PERT.

*The topics to be discussed in this course can be found in* text [1].

**Texts**

**Text 1 – Ravindran, Philps, Solberg.** ***Operations Research- Principles and Practice*****, 2nd Edition, Wiley India Pvt Ltd**

***References***

**Ref. 1 – Hamdy A. Taha.** ***Operations Research : An Introduction*****, 9th Edition, Pearson**

**SEMESTER-V**

**BUSINESS MATHEMATICS (OPEN COURSE)**

**CODE: MEC 1551.2** **Instructional hours per week: 3**
**No. of Credits: 2**

**Course Outcomes**

1. **Understand various factors in connection with Interest and discounts.**
2. **Acquire basic idea in differentiation.**
3. **Analyze various properties of integration.**
4. **Understand various Consumer concepts.**
5. **Analyze different properties of index numbers.**

**Module-I – Basic Mathematics of Finance** (18 hours)

Nominal rate of Interest and effective rate of interest, Continuous Compounding, force of interest, compound interest calculations at varying rate of interest, present value, interest and discount, Nominal rate of discount, effective rate of discount, force of discount, De- preciation.
(Chapter 8 of Unit I of text [1] - Sections: 8.1, 8.2, 8.3, 8.4. 8.5, 8.6, 8.7, 8.9)

**Module-II – Differentiation and their applications to Business and Economics**

(18 hours)

Meaning of derivatives, rules of differentiation, standard results (basics only for doing problems of chapter 5 of Unit 1)( Chapter 4 of unit I of text [1] - Sections: 4.3, 4.4, 4.5, 4.6 )Maxima and Minima, concavity, convexity and points of inflection, elasticity of demand,

Price elasticity of demand(Chapter 5 of Unit I of text [1] - Sections: 5.1, 5.2, 5.3, 5.4, 5.5. 5.6, 5.7)

Integration and their applications to Business and Economics: Meaning, rules of inte- gration, standard results, Integration by parts, definite integration (basics only for doing problems of chapter 7 of Unit 1 of text)
(Chapter 6 of unit I of text [1] - Sections: 6.1, 6.2, 6.4, 6.10, 6.11)
Marginal cost, marginal revenue, Consumer's surplus, producer's surplus, consumer's sur- plus under pure competition, consumer's surplus under monopoly
(Chapter 7 of unit I of text [1] - Sections: 7.1, 7.2, 7.3, 7.4, 7.5)

**Module-III – Index Numbers** **(**18 hours)
Definition, types of index numbers, methods of construction of price index numbers, Laspeyer's price index number, Paasche's price index number, Fisher ideal index num- ber, advantages of index numbers, limitations of index numbers
(Chapter 6 of Unit II of text [1] - Sections: 6.1, 6.3, 6.4, 6.5, 6.6, 6.8, 6.16, 6.17)
Time series: Definition, Components of time series, Measurement of Trend
(Chapter 7 of Unit II of text [1] - Sections: 7.1, 7.2, 7.4)

**Texts**

**Text 1 – B M Agarwal. *Business Mathematics and Statistics*, Vikas Publishing House, New Delhi, 2009**

***References***

**Ref. 1 – Qazi Zameeruddin, et al . *Business Mathematics*, Vikas Publishing House, New Delhi, 2009**

**Ref. 2 – Alpha C Chicny, Kevin Wainwright. *Fundamental methods of Mathematical Economics*, 4th Edition, Mc-Graw Hill**

**SEMESTER-V**

**BASIC MATHEMATICS (OPEN COURSE)**

**CODE: MEC1551.3** **Instructional hours per week: 3**
**No. of Credits: 2**

**Course Outcomes**

1. **Understand logics in Mathematics.**
2. **Analyze various properties and operations in numbers.**
3. **Familiar with basic concepts in Ratio and proportions.**
4. **Acquire knowledge of fundamentals in set theory.**
5. **Got good experience in fundamental Statistics.**

This course is specifically designed for those students who might have not undergone a mathematics course beyond their secondary school curriculum. The structure of the course is so as to give an exposure to the basic mathematics tools which found a use in day today life, say in the fields general finance and basic sciences.

**Module-I** : Basic arithmetic of whole numbers, fractions and decimals **(24 hours)**

Place Value of numbers, standard Notation and Expanded Notation, Operations on whole numbers : exponentiation, square roots, order of operations, computing averages, rounding, estimation, applications of estimation, estimating product of numbers by round- ing, exponents, square roots, order of operations, computing averages;
Fractions: multiplication and division of fractions, applications, primes and compos- ites, factorization, simplifying fractions to lowest terms, multiplication of fractions, recip- rocal of fractions, division of fractions, operations of mixed fractions, LCM,
Decimal notation and rounding of numbers, fractions to decimals, multiplication of decimals, division of decimals, order of operations involving decimals,
Scientific notation of numbers, operations in scientific notations, square and cube roots of numbers, laws of exponents and logarithms
*The topics to be discussed in this module can be found in chapters 1–3 of* text [1] *and chapters 1 and 2 of* text [2] *below.*

**Module II** - Ratios, proportions, percents and the relation among them **(15 hours)**

Ratio and proportions : Simplifying ratios to lowest terms, ratios of mixed numbers, unit rates and cost, ratios and proportion, similar figures;
Percents: Fractions - decimals - percents, converting between these three relation with proportions, equations involving percents, increase and decrease in percent, finding simple and compound interests
*The topics to be discussed in this module can be found in chapters 4, 5 of* text [1] *below.*

**Module -III** – Basic Statistics, Simple Equations **(15 hours)**

Basic Statistics : Data and tables, various graphs like bar graphs, pictographs, line graphs, frequency distributions and histograms, circle graphs (pie charts), interpreting them, circle graphs and percents, mean, median, mode, weighted mean

Solving simple equations, quadratic equations (real roots only), cubic equations, arith- metic geometric series, systems of two and three equations, matrices and system of equa- tions

*The topics to be discussed in this module can be found in chapters 9 of* text [1] *and chapters 2, 3 of* text [2] *below.*

**Texts**

**Text 1 – J Miller, M O'Neil, N Hyde. *Basic College Mathematics*, 2nd Edition, McGraw Hill Higher Education**

**Text 2 – Steven T Karris. *Mathematics for Business, Science and Technology*, 2nd Edi- tion, Orchard Publications**

***References***

**Ref. 1 – Charles P McKeague. *Basic Mathematics*, 7th Edition,Cengage Learning**

## SEMESTER-VI

## REAL ANALYSIS – II

**CODE: MEC 1641** **Instructional hours per week: 5**
**No. of credits: 4**

**Course Outcomes : At the end of Course ,the Student will be able to-**

**CO-1.Understand various versionofdefinitionoflimits and continuity of real valued functions.**
**CO-2.Understand the discontinuity criterion, uniform continuity, the intermediatevalue theorem and Monotone functions**
**CO-3.Understand the definition of differentiability offunctions and learn differentiability implies continuity.**
**CO-4.Learn certain important theorems connecting differentiability of a function.**
**CO-5.Learn Riemann integration .**

In the second part of the Real Analysis course, we focus on functions on R, their continuity, existence of derivatives, and integrability. The course is mainly based on Chapters 4,5 and 7 of text [1].

All the chapters mentioned above contains a section titled *Discussions* in the begin- ning of the chapter. These sections are intended only for motivating the students, and so should not be made a part of the examination process.

**Module-I** (35 Hours)

Herewemovetowardsthebasicnotionoflimitsoffunctionsandtheircontinuity. Various versionb of definitionoflimitsaretobediscussedhere. Thealgebraoflimitsoffunctionsand the divergence criterion for functional limits are to be discussed next. The other topicsto be discussed in this module are the discontinuity criterion, composition of functions and continuity, continuity and compct sets, results on uniform continuity, the intermediatevalue theorem, Monotone functions and theircontinuity.

*Thetopicstobediscussedinthismodulecanbefoundinchapter4of*text[1]*below.The firstsection4.1maybebrieflydiscussedandisnotmeantforexaminationpurposes.The subsection Preservation of connected sets may be omitted.*

**Module-II** (25 hours)

Here we discuss the derivative concept more rigorously than what was done in theprevious calculus courses. After (re)introducing the definition of differentiability offunctions, we verify that differentiability implies continuity. Algebra and composing of differentiablefunctionsshouldbediscussednext.The interior extremum theorem and Darboux's theorem should be discussed after that. The mean value theorems should be discussed and proved, and the module ends with L'Hospitals results. Acontinuouseverywherebut nowhere differentiable function should be discussed, but it is not meantfortheexamination. It may be infact used for studentseminars.

*Thetopicstobediscussedinthismodulecanbefoundinchapter5of*text[1]*below.The sections5.1and5.4maybebrieflydiscussedandisnotmeantforexaminationpurposes.*

**Module-III** (30 hours)

In the last module, the theory of Riemann integration is to be discussed. Main topics to be included in this module are defining the Riemann integral using upper, lower Riemann sums, and the integrability criterion, continuity and the existence of integral, algebraic operations on integrable functions, (The results and examples on convergence of sequence of functions and integrability may be omitted), the fundamental theorem of calculus and its proof, Lebesgue's criterion for Riemann integrability.

*Thetopicstobediscussedinthismodulecanbefoundinchapter7of*text[1]*below.The firstsection7.1maybebrieflydiscussedandisnotmeantforexaminationpurposes.*

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**Texts**

**Text 1 – Stephen Abbot; *Understanding Analysis*, 2nd Edition, Springer,2015.**

***References***

**Ref. 1 – R G Bartle, D Sherbert ; *Introduction to real analysis*, 3rd Edition, John Wiley & Sons**

**Ref. 2 – W. Rudin, *Principles of Mathematical Analysis*, Second Edition, McGraw-Hill.**

**Ref. 3 – Terrence Tao; *Analysis I*, Hindustan Book Agency**

## COMPLEX ANALYSIS – II

**CODE: MEC 1642** **Instructional hours per week: 5**
**No. of credits: 4**

**Course Outcomes : At the end of the Course ,the Student will be able to-**

**CO-1.Learn the well-known Cauchy's Integral Theorem.**
**CO-2.Learn the Cauchy's Integral formula**
**CO-3.Learn Taylor Series and Laurent series representations of analytic functions.**
**CO-4.Learn the Residue Theory of Complex functions.**

**Module-I** (35 Hours)

Series Representations for Analytic Functions : Sequences and Series, Taylor Series, Power Series, Mathematical Theory of Convergence, Laurent series, Zeros and Singularities, The point at Infinity. *The topics to be discussed in this module can be found in chapter 5, sections 5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7 of* text [1] *below.*

**Module-II** (30 Hours)

Residue Theory : The Residue Theorem, Trigonometric Integrals over $[0, 2\pi]$, Improper integrals of Certain functions over $[-\infty, \infty]$, Improper integrals involving Trigonometric Functions, Indented Contours

*The topics to be discussed in this module can be found in chapter 6, sections 6.1, 6.2, 6.3, 6.4, 6.5 of* text [1] *below.*

**Module III** (25 Hours)

Conformal Mapping : Geometric Considerations, Mobius Transformations

*The topics to be discussed in this module can be found in chapter 7, sections 7.2, 7.3, 7.4 of* text [1] *below.*

**Texts**

**Text 1 –** Edward B. Saff, Arthur David Snider. *Fundamentals of complex analysis with applications to engineering and science*, 3rd Edition, Pearson Education, India.

***References***

**Ref. 1 –** John H Mathews, Russel W Howell. *Complex Analysis for Mathematics and Engineering*, 6th Edition, Jones and Bartlett Publishers

Ref. 2 – Murray R Spiegel. *Complex variables: with an introduction to conformal mapping and its applications*, Schaum's outline.

Ref. 3 – Erwin Kreyszig. *Advanced Engineering Mathematics*, 10th Edition, Wiley-India

Ref. 4 – James Brown, Ruel Churchill. *Complex Variables and Applications*, Eighth Edition, McGraw-Hill

**PROJECT PREPARATION -**
**FROM SELECTING THE TOPIC TO PRESENTING THE FINAL REPORT**

**CODE: MEC 1643** **Instructional hours per week: 1**
**No. of credits: 4**

To complete the undergraduate programme, the students should undertake a project and prepare and submit a project report on a topic of their choice in the subject math- ematics or allied subjects. The work on the project should start in the beginning of the 5th semester itself, and should end towards the middle of the 6th semester. This course (without any examination in the 5th semester, with a project report submissin and project viva in the 6th semester) is introduced for making the students understand various con- cepts behind undertaking such a project and preparing the final report. Towards the end of this course the students should be able to choose and prepare topics in their own and they should understand the layout of a project report.

To quickly get into the business, the first chapter of text [1] may be completely dis- cussed. Apart from that, for detailed information, the other chapters in this book may be used in association with the other references given below. The main topics to discuss in this course are the following:

**Quick overview :** The structure of Dissertation, creating a plan for the Dissertation, planning the results section, planning the introduction, planning and writing the abstract, composing the title, figures, tables, and appendices, references, making good presentations, handling resources like notebooks, library, computers etc., preparing an interim report.
**Topics in detail :** Planning and Writing the Introduction, Planning and Writing the Results, Figures and Tables, Planning and Writing the Discussion, Planning and Writing the References, Deciding On a Title and Planning and Writing the Other Bits, Proofread- ing, Printing, Binding and Submission, oral examinations, preparing for viva, Taking the Dissertation to the Viva
Layout : Fonts and Line Spacing, Margins, Headers, and Footers, Alignment of Text, Titles and Headings, Separating Sections and Chapters

**Texts**

Text 1 – Daniel Holtom, Elizabeth Fisher. *Enjoy Writing Your Science Thesis or Dissertation – A step by step guide to planning and writing dissertations and theses for undergraduate and graduate science students*, Imperial College Press

**References**

Ref. 1 – Kathleen McMillan, Jonathan Weyers. *How to write Dissertations & Project Reports*, Pearson Education Limited

Ref. 2 – Peg Boyle Single. *Demystifying dissertation writing : a streamlined process from choice of topic to final text*, Stylus Publishing, Virginia