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)

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# FIRST MAIN: ECONOMICS: SCHEME AND SYLLABUS

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PROGRAMME SPECIFIC OUTCOMES (PSO)
FOR B.A. ECONOMICS AND MATHEMATICS
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<th>To provide a strong foundation in Economics and Mathematics</th>
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<td>To enable students to acquire necessary skills for analyzing basic economic issues at the micro and macro levels</td>
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<td>To acquaint students with the essential mathematical and statistical methods and tools to be applied in the analytical aspects of Economics.</td>
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<td>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</td>
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<td>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</td>
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<td>PSO6</td>
<td>To create academic excellence through holistic education.</td>
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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

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<td>To familiarize the students with the methodologies, tools and analysis procedures in economics</td>
<td>PSO 2</td>
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<td>To create an enthusiasm among students, incorporating various concepts and issues in economics.</td>
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<td>Discuss on the topic: Capitalism as an economic system</td>
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<td>To understand major global economic crisis and contemporary issues in economics</td>
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<td>Understand</td>
<td>Analyze</td>
<td>Assignment on Great depression (1929) and the Global financial crisis (2008)</td>
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**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


**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


**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.


Module IV: Major Global Economic Events & Contemporary Economic Issues


References

Module I:


Module II


Module III, IV & V

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

MEC 1132: INTRODUCTORY MICROECONOMICS

4 hours 3 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 1132-Introductory Micro Economics

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MEC 1132: Tagging Course Outcomes

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<td>Evaluating the types, measurement and practical uses of the concept of elasticity of demand and supply</td>
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<td>Assignment on the practical uses and mathematical treatment of the concept of elasticity</td>
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<td>Evaluate</td>
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<td>Assignment on the comparative analysis of the theories of consumer behaviour.</td>
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<td>Analyzing the basic theories of production function both in the short run and long run and the Cobb Douglas production function.</td>
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<td>Analyse</td>
<td>Assignment on the practical uses and mathematical treatment of theories of production</td>
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<tr>
<td>CO5</td>
<td>Analysing the types of costs in production</td>
<td>PSO2</td>
<td>Apply</td>
<td>Conceptual</td>
<td>Assignment on the mathematical treatment of cost theory</td>
</tr>
<tr>
<td>CO6</td>
<td>Examining the price and output determination in perfectly competitive and monopoly markets.</td>
<td>PSO2</td>
<td>Apply</td>
<td>Conceptual</td>
<td>Assignment on the mathematical treatment of the determination of equilibrium price and output</td>
</tr>
</tbody>
</table>

**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)


**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


Module IV Market Structures I (25hrs)


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

Additional Readings

 Semester II

MEC 1221: Introduction to Environmental Economics
(Foundation II)

Instructional Hours – 3
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

<table>
<thead>
<tr>
<th>CO</th>
<th>CO Statement</th>
<th>Cognitive Level</th>
<th>Knowledge Category</th>
<th>Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>By familiarizing the students the association of the economy and environment</td>
<td>Analysis</td>
<td>Procedural</td>
<td>An assignment on portraying the relationship between economy and environment.</td>
</tr>
<tr>
<td>CO2</td>
<td>By enabling the students to develop a comprehensive knowledge on the environmental theories for analysis</td>
<td>Analysis</td>
<td>Procedural</td>
<td>An essay on the environmental theories for analysis</td>
</tr>
<tr>
<td>CO3</td>
<td>By imparting the skills essential for understanding and solving the environmental issues.</td>
<td>Evaluate</td>
<td>Procedural</td>
<td>An evaluation of skills to identifying the real environmental issues at global level.</td>
</tr>
</tbody>
</table>
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, resilience and Risk - Vulnerability Profile Disaster management in India

References

- 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 MICROECONOMICS

<table>
<thead>
<tr>
<th>Course Outcome</th>
<th>CO Statement</th>
<th>PSO</th>
<th>Cognitive Level</th>
<th>Knowledge Category</th>
<th>Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>To understand general idea about monopolistic and oligopolistic markets</td>
<td>PSO 1</td>
<td>Analyze</td>
<td>Conceptual</td>
<td>Class room discussion on the relevance of monopolistic competition in our daily life</td>
</tr>
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<td></td>
<td>Understanding the peculiar characteristics of monopolistic competition as a market form in comparison with monopoly</td>
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<tr>
<td>CO2</td>
<td>To study markets for factor inputs</td>
<td>PSO 1</td>
<td>Analyze</td>
<td>Conceptual</td>
<td>Class room discussion on the existence of oligopoly market form in our daily life</td>
</tr>
<tr>
<td></td>
<td>Examine the peculiar characteristics of oligopoly as a market form in</td>
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</tr>
<tr>
<td>CO3</td>
<td>Understanding the concept of competitive factor market</td>
<td>PSO 1</td>
<td>Understand</td>
<td>Conceptual</td>
<td>Assignment on different types of factor markets</td>
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<tr>
<td>CO4</td>
<td>Identifying the situation of equilibrium in factor market</td>
<td>PSO 5</td>
<td>Evaluate</td>
<td>Conceptual</td>
<td>Class room discussion on different situations of disequilibrium in the labour market</td>
</tr>
<tr>
<td>CO5</td>
<td>Learning Net present value criterion for capital investment decisions</td>
<td>PSO 2</td>
<td>Understanding</td>
<td>Conceptual</td>
<td>Class room discussion on capital investment decisions</td>
</tr>
<tr>
<td>CO6</td>
<td>Understand the concepts of risk, probability, expected value and variability in possible outcome</td>
<td>PSO 1</td>
<td>Understand</td>
<td>Conceptual</td>
<td>Class room discussions on practical awareness on risk, probability, expected value and variability</td>
</tr>
<tr>
<td>CO7</td>
<td>Learning general equilibrium analysis in terms of efficiency of exchange</td>
<td>PSO 1</td>
<td>Analyse</td>
<td>Conceptual</td>
<td>Assignment on General equilibrium analysis</td>
</tr>
</tbody>
</table>
COURSE STRUCTURE

Module I: Market Structures II  
(30Hrs)


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

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


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

Module III: Risk and Uncertainty  
(20 hrs)


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

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


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

Reference

1. Robert S. Pindyck, Daniel L. RubinfeldMicroeconomics, 8th Ed , Pearson India Education Services Pvt Ltd
Additional Readings:


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 the basic concepts of Macroeconomics. Macroeconomics deals with the aggregate economy. This course discusses the preliminary concepts associated with the determination and measurement of aggregate macroeconomic variable like GDP, savings, investment, money, inflation, and the balance of payments. It also introduces students to simple analytical frameworks for determination of equilibrium output.

<table>
<thead>
<tr>
<th>Name of the course: MEC 1331: INTRODUCTORY MACROECONOMICS</th>
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</thead>
<tbody>
<tr>
<td><strong>Course Outcomes</strong></td>
</tr>
<tr>
<td><strong>CO 1</strong> To understand the concept of national income and different methods of measuring it.</td>
</tr>
<tr>
<td><strong>CO 2</strong> To summarize the contributions made by the classical economists in macroeconomics.</td>
</tr>
<tr>
<td><strong>CO 3</strong> To summarize the contributions made by the Keynesian economists in macroeconomics.</td>
</tr>
<tr>
<td><strong>CO 4</strong> To understand the concept of money and the factors contributing demand for money</td>
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<th>MEC 1331: Tagging Course Outcomes</th>
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</table>

**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.


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

MODULE III: Keynesian Macro Economic system (23 Hours)


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


References

2. Richard Froyen, Macroeconomics: Theories and Policies, 10th ed, Pearson Education

Additional Readings

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.

<table>
<thead>
<tr>
<th>Course Outcome</th>
<th>CO Statement</th>
<th>PSO</th>
<th>Cognitive Level</th>
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<th>Assessment</th>
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</thead>
<tbody>
<tr>
<td>CO 1</td>
<td>By enabling the students to understand the concepts of growth and development, basic characteristics of LDCs, obstacles to grow and the Development Gaps</td>
<td>PSO 1</td>
<td>Evaluate</td>
<td>Procedural</td>
<td>An evaluation of the characteristics of LDCs</td>
</tr>
<tr>
<td>CO 2</td>
<td>By familiarizing students with the different tools used in measuring growth and development.</td>
<td>PSO 1</td>
<td>Analysis</td>
<td>Procedural</td>
<td>Assignment on analyzing the calculation of different development indices and a comparison between them.</td>
</tr>
<tr>
<td>CO 3</td>
<td>By imparting an understanding of the different growth models</td>
<td>PSO 1</td>
<td>Analysis</td>
<td>Procedural</td>
<td>An analysis of the applicability of the theories in the present world.</td>
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</table>

COURSE STRUCTURE

MODULE I: CONCEPTIONS OF DEVELOPMENT (18 Hours)

**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)**


**References**

3. Thirwall (2006), Growth and Development with Special Reference to Developing countries, Mcmillan, New Delhi.
MEC 1333: Game Theory

3 Hours

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.

<table>
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<tr>
<th>NAME OF THE COURSE: MEC 1333: Game Theory</th>
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**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. RubinfeldMicroeconomics, 8th Ed, Pearson India Education Services Pvt Ltd
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.

<table>
<thead>
<tr>
<th>Name of the course: MEC 1431: INTERMEDIATE MACROECONOMICS</th>
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<tr>
<td><strong>Course Outcomes</strong></td>
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<th>MEC 1431: Tagging Course Outcomes</th>
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</table>

**COURSE STRUCTURE**

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

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)


**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.


References

MEC 1432: Statistical Methods for Economics I

4 Hours 4 Credits

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 courses in advanced microeconomic theory.

Name of the course: MEC 1432: Statistical Methods for Economics

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<th>Course Outcomes</th>
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MEC 1432: Tagging Course Outcomes

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<th>CO</th>
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<th>PSO</th>
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<th>Knowledge Category</th>
<th>Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO 1</td>
<td>Understanding the measures of Central Tendency and Dispersion in order to interpret empirical data</td>
<td>PSO 3</td>
<td>Understand</td>
<td>Analyze</td>
<td>Assignment of collection of some data for which the various measures of central tendency can be computed.</td>
</tr>
</tbody>
</table>
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)

Summarizing categorical data- Frequency Distribution, Relative Frequency and Percent Frequency Distributions, Bar Charts and Pie Charts; Summarizing Quantitative Data- Frequency Distribution, Relative Frequency and Cumulative Frequency Distributions, Dot Plot, Histogram, Cumulative Distributions, Ogive; Cross tabulations and Scatter 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 coefficient; 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


Additional Readings

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.

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<tr>
<th>Course Outcome</th>
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<th>PSO</th>
<th>Cognitive level</th>
<th>Knowledge Category</th>
<th>Assessment</th>
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</thead>
<tbody>
<tr>
<td>CO1</td>
<td>To understand the various instruments in the money market</td>
<td>PSO 4</td>
<td>Understand</td>
<td>Conceptual</td>
<td>Assignment on: Features of Indian Money market.</td>
</tr>
<tr>
<td>CO2</td>
<td>To understand the basic concepts of the capital market</td>
<td>PSO 4</td>
<td>Understand</td>
<td>Conceptual</td>
<td>Assignment on the functions of SEBI</td>
</tr>
<tr>
<td>CO3</td>
<td>To enable students to know the operation of the</td>
<td>PSO 4</td>
<td>Understand</td>
<td>Conceptual</td>
<td>Assignment on Indian Financial system.</td>
</tr>
</tbody>
</table>
COURSE STRUCTURE

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

Module II: Capital Market (8 Hours)

Module III: Security Market Analysis (8 Hours)

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
• Khan, N Y (1996): Indian Financial system, TATA Mc Graw Hill Co Ltd, 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.

CO 3 - 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.

<table>
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<tr>
<th>Course Outcome</th>
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<th>PSO</th>
<th>Cognitive Level</th>
<th>Knowledge Category</th>
<th>Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO 1</td>
<td>By enabling the students to understand the basic concepts related to International trade and the traditional theories of trade</td>
<td>PSO 1</td>
<td>Analysis</td>
<td>Procedural</td>
<td>An assignment on the application of Traditional theories in the present world.</td>
</tr>
<tr>
<td>CO 2</td>
<td>By evaluating the trade policies and their effects on trade.</td>
<td>PSO 5</td>
<td>Evaluate</td>
<td>Procedural</td>
<td>An evaluation of free trade and protection in India.</td>
</tr>
<tr>
<td>CO3</td>
<td>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.</td>
<td>PSO 1</td>
<td>Analysis</td>
<td>Procedural</td>
<td>An analysis of economic crisis due to BOP disequilibrium in different countries of the world, w.r.t., India</td>
</tr>
<tr>
<td>CO4</td>
<td>Enabling students to have a basic understanding of the emerging trends in the field of international economic system.</td>
<td>PSO 1</td>
<td>Evaluate</td>
<td>Procedural</td>
<td>An evaluation of changes in International economics over the years.</td>
</tr>
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</table>

**COURSE STRUCTURE**

**Module I: Theories of International Trade**

(23 Hours)


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)


**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 Commercial Policy**


**References**


**Additional Readings**


MEC 1532: Statistical Methods for Economics II

4 Credit

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.

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<th>PSO</th>
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<th>Knowledge Category</th>
<th>Assessment</th>
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</thead>
<tbody>
<tr>
<td>CO 1</td>
<td>To Carry out estimation of standard Parametric and Non-parametric tests used in social science research.</td>
<td>PSO 3</td>
<td>Understand</td>
<td>Analyze</td>
<td>Practical questions on one tailed and two tailed tests</td>
</tr>
</tbody>
</table>
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


Additional Readings

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 of simple linear regression model and providing a basic idea about the multiple regression model.

CO3- To enable them to understand the violations of classical assumptions.

<table>
<thead>
<tr>
<th>Course Outcome</th>
<th>CO Statement</th>
<th>PSO</th>
<th>Cognitive Level</th>
<th>Knowledge Category</th>
<th>Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO 1</td>
<td>By providing an understanding of the fundamental concepts necessary for the study of econometrics.</td>
<td>PSO 3</td>
<td>Understand</td>
<td>Conceptual</td>
<td>An assignment on the Methodology of Econometrics.</td>
</tr>
<tr>
<td>CO 2</td>
<td>By familiarising the OLS method and the properties of estimators using the Gauss Markov Theorem.</td>
<td>PSO 3</td>
<td>Analyze</td>
<td>Procedural</td>
<td>An assignment on estimating parameters from an appropriate problem</td>
</tr>
</tbody>
</table>
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)

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)

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

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 | Cognitiv e Level | Knowledg e 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 |
COURSE STRUCTURE

Module 1: Growth process in Indian Economy  


Module 2: Agriculture and Industry since independence  

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


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


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


Vinoj Abraham (2017)Stagnant Employment Growth Last Three Years May Have Been the WorstVo.52, Issue No.38,23 Sep 2017, EPW
Module 2


Module 3


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

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

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


Module 4

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


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


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

<table>
<thead>
<tr>
<th>Project Report Indicators</th>
<th>Score</th>
<th>Weightage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Introduction and</td>
<td>10%</td>
<td></td>
</tr>
<tr>
<td>Review of literature</td>
<td></td>
<td></td>
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<tr>
<td>2. Methodology</td>
<td>20%</td>
<td></td>
</tr>
<tr>
<td>3. Analysis</td>
<td>40%</td>
<td></td>
</tr>
<tr>
<td>4. Conclusion &amp; Suggestion</td>
<td>20%</td>
<td></td>
</tr>
<tr>
<td>5. Bibliography</td>
<td>10%</td>
<td></td>
</tr>
</tbody>
</table>

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)

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


Reference

- PK Sinha, Computer Fundamentals, BPB Publications
- RamezElmasri and Shamkant B Navathe, Fundamentals 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**


**References**


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 onwards 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 remainder 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, Euler's theorem, The topics to be discussed in this module can be found in chapter 2 and 3 of text [1] below.

**Texts**


**References**

Differential Equations

Code: MEC1241  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. Sufficient 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), separable ODEs, reduction to separable form, exact ODEs and integrating factors, reducing to exact form, homogeneous and non homogeneous linear ODEs, special equations like Bernoulli equation, orthogonal trajectories, 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 solutions, 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 wronskian, solving nonhomogeneous ODE via the method of undetermined coefficients, various 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


References
VECTORS 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 dimensional rectangular co-ordinate system should be discussed and how distance is to be calculated between points in this system. 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, equations of planes using vectors normal to be should be discussed. Quadric surfaces which are three dimensionaonal 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 interpretation 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**

References


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 functions of more than one variable, the sketching of them in three dimensional 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 intersections 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

References

ABSTRACT ALGEBRA – GROUP THEORY
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 motivate 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 notion 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**

Here the concept of group homomorphisms should be defined with sufficient number of examples. After proving the first isomorphism theorem, the fundamental theorem of isomorphism 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**


**References**

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 discussed 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 discussed. 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 irreducibility and reducibility and the unique factorization of polynomials over special rings should be discussed.

*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 also to be discussed.

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

**Texts**


**References**


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

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**LINEAR ALGEBRA**

**Code:** MEC 1442  
**Instructional hours per week:** 5
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 interpretation of linear equations, following topics should be discussed: various operations on column vectors, technique of Gaussian elimination, operations involving 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 $\mathbb{R}^n$, 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. After 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, linearity 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


References


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 stepping 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 introduction 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 numbers, Density of Q in R, existence of square roots, countability of Q and uncountability of R, various cardinality results, Cantor’s original proof for uncountability 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 geometric progression. After discussing the rearrangement concept of infinite series, the following topics are to be introduced rigorously: Limit of a sequence, diverging sequences, 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 \( \mathbb{R} \), 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**


**References**

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


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

Here we go through the basic complex function theory.

Module-I

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

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

Complex Integration: Contours, Contour Integrals, Independence of Path, Cauchy’s Integral Theorem (Section 4.4a on deformation of Contours Approach is to be discussed, but section 4.4b 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


References


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.
4. Solve transportation problems using different methods.
5. Understand basic concepts in project management.

Module-I – Linear Programming
Formulation of Linear Programming models, Graphical solution of Linear Programs in two variables, Linear Programs in standard form - basic variable - basic solution- basic feasible 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 ≥ or = type.)

Module-II – Transportation Problems
Linear programming formulation - Initial basic feasible solution (Vogel’s approximation method/North-west corner rule) - degeneracy in basic feasible solution - Modified distribution method - optimality test.


Module-III – Project Management
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


References

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 integration, 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

References

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 composites, factorization, simplifying fractions to lowest terms, multiplication of fractions, reciprocals 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, arithmetic geometric series, systems of two and three equations, matrices and system of equations

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**


**References**

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

CO-1. Understand various versions of definitions of limits and continuity of real valued functions.
CO-2. Understand the discontinuity criterion, uniform continuity, the intermediate value theorem and Monotone functions
CO-3. Understand the definition of differentiability of functions 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 contain a section titled Discussions in the beginning 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)

Here we move towards the basic notions of limits of functions and their continuity. Various versions of definitions of limits are to be discussed here. The algebra of limits of functions and the divergence criterion for functional limits are to be discussed next. The other topics to be discussed in this module are the discontinuity criterion, composition of functions and continuity, continuity and compact sets, results on uniform continuity, the intermediate value theorem, Monotone functions and their continuity.

The topics to be discussed in this module can be found in Chapter 4 of text [1] below. The first section 4.1 may be briefly discussed and is not meant for examination purposes. 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 the previous calculus courses. After (re)introducing the definition of differentiability of functions, we verify that differentiability implies continuity. Algebra and composing of differentiable functions should be discussed next. 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’Hospital’s results. A continuous everywhere but nowhere differentiable function should be discussed, but it is not meant for the examination. It may be infact used for student seminars.
Thetopicstobediscussedinthismodulecanbefoundinchapter5oftext[1]below.The sections5.1 and 5.4 may be briefly discussed and is not meant for examination purposes.

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.

Thetopicstobediscussedinthismodulecanbefoundinchapter7oftext[1]below. The first section 7.1 may be briefly discussed and is not meant for examination purposes.

Texts

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


Ref. 3 – Terrence Tao; *Analysis I*, Hindustan Book Agency
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-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 [−∞, ∞], 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

References


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 mathematics 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 submission and project viva in the 6th semester) is introduced for making the students understand various concepts 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 discussed. 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, Proofreading, 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**
