Details of Course:

Course Title	Course Structure			Pre-Requisite
~~MCAC~~ MC404 **Numerical Methods for PDE**	L	T	P	Some knowledge of numerical methods, PDEs and MATLAB
	3	1	0	

Course Objective: The objective of this course is to learn computational solution of PDEs.

Course Outcome (CO):

CO1	Classify partial differential equations (PDEs), identify mathematical models in engineering, and adapt basic concepts like accuracy, consistency, and stability associated with the numerical methods.
CO2	Solve elliptic PDEs using numerical methods, analyze numerical methods for consistency, stability and convergence
CO3	Apply numerical methods such as Jacobi, Gauss-Seidel, Crank-Nicolson, and Lax-Wendroff to solve engineering problems involving parabolic and hyperbolic PDEs.
CO4	Analyze the stability, consistency, and convergence of finite difference methods used for solving PDEs, using techniques like the CFL condition and Von Neumann stability analysis.
CO5	Explain the existence, uniqueness, and regularity of weak solutions, calculate and assemble the stiffness matrix, and apply finite element method to solve 1D and 2D problems

S. No.	Contents	Contact Hours
UNIT 1	Introduction to Partial Differential Equations(PDEs) - Classification of PDEs, Examples of PDEs in engineering: Heat equation, Wave equation, Laplace equation. Analytical methods: separation of variables, Fourier series solution. Introduction to Numerical Methods: Basic concepts, accuracy, consistency, and stability.	10
UNIT 2	Finite Difference Methods for Elliptic PDEs - Finite difference approximations. Solution of Laplace and Poisson Equations: Five-point and nine-point formulae. Consistency, stability and Convergence of different schemes.	10
UNIT 3	Finite Difference Methods for Parabolic PDEs - Explicit and Implicit Schemes: Euler, Crank-Nicolson schemes for parabolic equations. Consistency, Stability and convergence: CFL condition, Von Neumann stability analysis.	8
UNIT 4	Finite Difference Methods for Hyperbolic PDEs: Lax-Friedrichs, Lax-Wendroff methods, Leapfrog method, Consistency, Stability and convergence of different schemes	5
UNIT 5	Finite Element Methods for PDEs - Introduction to Finite Element Method in 1D and 2D problem in (FEM): Variational formulation, weak solutions. Linear and quadratic elements, assembly of the stiffness matrix, Error analysis, Application to elliptic and parabolic equations: Galerkin method.	9
	TOTAL	42

Suggested Books:

S. No.	Name of Books/Authors/Publishers	Year of Publication
1	R. J. LeVeque, Finite Difference Methods for Ordinary and Partial Differential Equations: Steady-State and Time-Dependent Problems, SIAM.	2007
2	G. D. Smith, Numerical Solution of Partial Differential Equations: Finite Difference Methods, Oxford University Press.	1985
3	K. W. Morton and D. F. Mayers, Numerical Solution of Partial Differential Equations: An Introduction, Cambridge University Press.	2005
4	J. C. Strikwerda, Finite Difference Schemes and Partial Differential Equations, SIAM.	2004
5	S. C. Brenner and L. R. Scott, The Mathematical Theory of Finite Element Methods, Springer.	2008
6	O. C. Zienkiewicz, R. L. Taylor, and J. Z. Zhu: The Finite Element Method: Its Basis and Fundamentals, Butterworth-Heinemann.	2005

Details of Course:

Course Title	Course Structure			Pre-Requisite
MC405	L	T	P	Real Analysis,
Optimization Techniques	3	0	2	Linear Algebra

Course Objective: The general objectives of the course is to introduce the fundamental concepts of Optimization Techniques that make the learners aware of the importance of optimizations in real scenarios and provide the concepts of various classical and modern methods of for constrained and unconstrained problems in both single and multivariable.

Course Outcome (CO):

CO1	Define and use optimization concepts to model the real-world applications as an optimization problem.
CO2	Apply optimization methods to engineering problems, including developing a model, defining an optimization problem, applying optimization methods, exploring the solution, and interpreting results.
CO3	Formulate continuous problems into unconstrained and constrained optimization problems on the basis of the conditions provided .
CO4	Identify the optimization techniques to determine a robust design for a given real world problem and justify the technique for solving it.
CO5	Employ basic optimization algorithms in a computational setting and apply existing optimization software packages to solve and analyze the interdisciplinary real-world problems and for higher study and research.

S.No.	Contents	Contact Hours
UNIT 1	Convex functions and their properties, Convex optimization problems, Convex programming problems, Quadratic programming problems, wolf method for quadratic programming.	9
UNIT 2	Unconstrained Optimization- Line search Algorithm, Steepest Descent Method and Conjugate Gradient Method.	8
UNIT 3	Introduction, feasible directions and linearizing cone, Basic constraint qualification, Lagrange multipliers, Karush Kuhn Tucker necessary/sufficient optimality conditions.	8
UNIT 4	Duality in nonlinear programming, wolf dual, mixed dual and Lagrange dual.	8
UNIT 5	Franck and wolf's method, Gradient projection method, Penalty function method, barrier function method.	9
	TOTAL	42

Suggested Books:

S.No.	Name of Books/Authors/Publishers	Year of Publication
1	C.R.Bector, S.Chandra, J. Dutta, Principles of Optimization Theory, Narosa Publications.	2016
2	M.S. Bazaraa, H.D.Sherali, & C.M. Shetty, Nonlinear Programming Theory & Algorithms, John Willey & Sons.	2006
3	Suresh Chandra, Jayadeva, Aparna Mehra, Numerical optimization with applications, Narosa Publications.	2009
4	Singiresu S. Rao, Engineering Optimization: Theory and Practice, John Wiley &Sons.	2009
5	N.S. Kambo, Mathematical Programming Techniques, East-West Press Pvt. Ltd.	2008

PRACTICALS LIST	
1	Program to check whether a given function is convex or not
2	Program to check whether a given function is convex or not by using Hessian Matrix
3	Program to check whether the given optimization function is convex or not
4	Program to derive the KKT conditions for a given optimization problem
5	Program to solve a given optimization problem using Lagrange Method
6	Program to solve the quadratic programming problem by Wolfe Method
7	Program to solve a non-linear programming problem using Frank-Wolfe Algorithm
8	Program to solve linear fractional programming problem using Charnes and Cooper Method
9	Program to solve a given NLPP using Penalty Method
10	Program to solve a given NLPP using Barrier function method

Details of Course:

Course Title	Course Structure			Pre-Requisite
MC406:	L	T	P	Knowledge of linear algebra, differential equations & Scientific Computing
Finite Element Methods	3	1	0	

Course Objective: This course provide the fundamental concepts of the theory of the finite element method to give understanding of the fundamental theory of the FEA method to develop the ability to generate the governing FE equations for systems governed by partial differential equations and enhance the ability use of the basic finite elements for structural applications using truss, beam, frame, and plane elements and understand the application and use of the FE method for heat transfer problems.

Course Outcome (CO):

CO1	Describe the fundamental concepts of function spaces, including continuous, integrable, and Sobolev spaces, and explain the existence, uniqueness, and regularity of weak solutions for elliptic boundary value problems.
CO2	Apply finite element methods using piecewise linear basis functions, calculate and assemble the stiffness matrix, and demonstrate the Galerkin orthogonality and Cea's lemma in solving self-adjoint elliptic problems.
CO3	Analyze polynomial approximation in Sobolev space, evaluate error bounds in the energy norm, identifying the sources of variational crimes in finite element methods.
CO4	Assess the reliability, efficiency, and adaptivity of finite element solutions using a posteriori error analysis by duality and apply this knowledge to optimize computational methods.
CO5	Design finite element approximations for initial boundary value problems, ensuring energy conservation, stability, and dissipation, and develop appropriate strategies for solving evolution problems in computational mechanics.

S. No.	Contents	Contact Hours
UNIT 1	Elements of function spaces: spaces of continuous functions, spaces of integrable functions, Sobolev spaces, Elliptic boundary value problems: existence, uniqueness and regularity of weak solutions.	7
UNIT 2	Finite element methods: piecewise linear basis functions, the self-adjoint elliptic problem, calculation and assembly of stiffness matrix, Galerkin orthogonality and Cea's lemma, optimal error bound in the energy norm, The Aubin-Nitsche duality argument, super approximation in mesh dependent norms.	12
UNIT 3	Piecewise polynomial approximation: construction of finite element spaces, polynomial approximation in Sobolev space: The Bramble-Hilbert lemma, optimal error bounds in the energy norm, variational crimes. A posteriori error analysis by duality: reliability, efficiency and adaptivity.	12
UNIT 4	Finite element approximation of initial boundary value problems, Energy dissipation, conservation and stability. Analysis of finite element methods for evolution problems.	11
	TOTAL	42

Suggested Books:

S. No.	Name of Books/Authors/Publishers	Year of Publication
1	Endre Suli and David Mayerf, An introduction to numerical analysis, Cambridge University Press, 2nd Ed.	2006
2	S. C. Brenner and R. L. Scott, The Mathematical Theory of Finite Element Methods, Springer-Verlag, New York, 2nd Ed.	2002
3	P.G. Ciarlet, The Finite Element Methods for Elliptic Problems, North Holland, Amsterdam.	1978
4	C. Johnson, Numerical solutions of Partial Differential Equations by Finite Element Methods, Cambridge University Press, Cambridge.	1987
5	M. Ainsworth and J. T. Oden, A Posteriori Error Estimation in Finite Element Analysis, John Wiley and Sons.	2000
6	V. Thomee, Galerkin, Finite Element Methods for Parabolic Problems, Springer-Verlag, Berlin, 2nd Ed.	2006

Details of Course:

Course Title	Course Structure			Pre-Requisite
MC407 **Numerical Methods for ODE**	L	T	P	Knowledge of numerical methods, ODE and Matlab/Python
	3	1	0	

Course Objective: The objective of the course is to learn how to solve real life problems.

Course Outcome (CO):

CO1	Interpret the basics of numerical methods for initial value problems.
CO2	Analyse the various error involved in the numerical scheme.
CO3	Differentiate and apply appropriate techniques for numerical techniques for solving ODE.
CO4	Solve initial value problem with explicit or implicit methods as appropriate.
CO5	Analyze the stability of the numerical schemes applied to various types of BVP's.

S. No.	Contents	Contact Hours
UNIT 1	Initial Value Problems: Euler's method, modified Euler's method, Taylor series method, Runge-Kutta methods and their convergence.	10
UNIT 2	Multistep methods: Trapezoidal method, 2-step Adams-Bash forth method, Two-step method: consistency, zero stability, local and global analysis. Concept of A-stability.	10
UNIT 3	Absolute Stability for system of Ordinary Differential Equations, Stiff Ordinary Differential Equations: Numerical difficulties, Characterizations of stiffness, Numerical methods for stiff problems, A-stability, L-stability.	10
UNIT 4	Shooting method, Finite difference method (forward, backward and central) for two-point boundary value problems, Consistency, stability and their convergence.	12
	TOTAL	42

Suggested Books:

S. No.	Name of Books/Authors/Publishers	Year of Publication
1	Randall Leveque, Finite difference methods for ordinary and partial differential equations, SIAM	2007
2	David F. Griffiths, Desmond J. Higham, Numerical methods for ordinary differential equations, springer	2010
3	A. Iserles, A first course in the Numerical analysis of differential equations, Cambridge	2008
4	M.K. Jain and S.R.K. Iyenger, Numerical methods for Scientific and Engineering. Computation, New Age International Publishers	2007
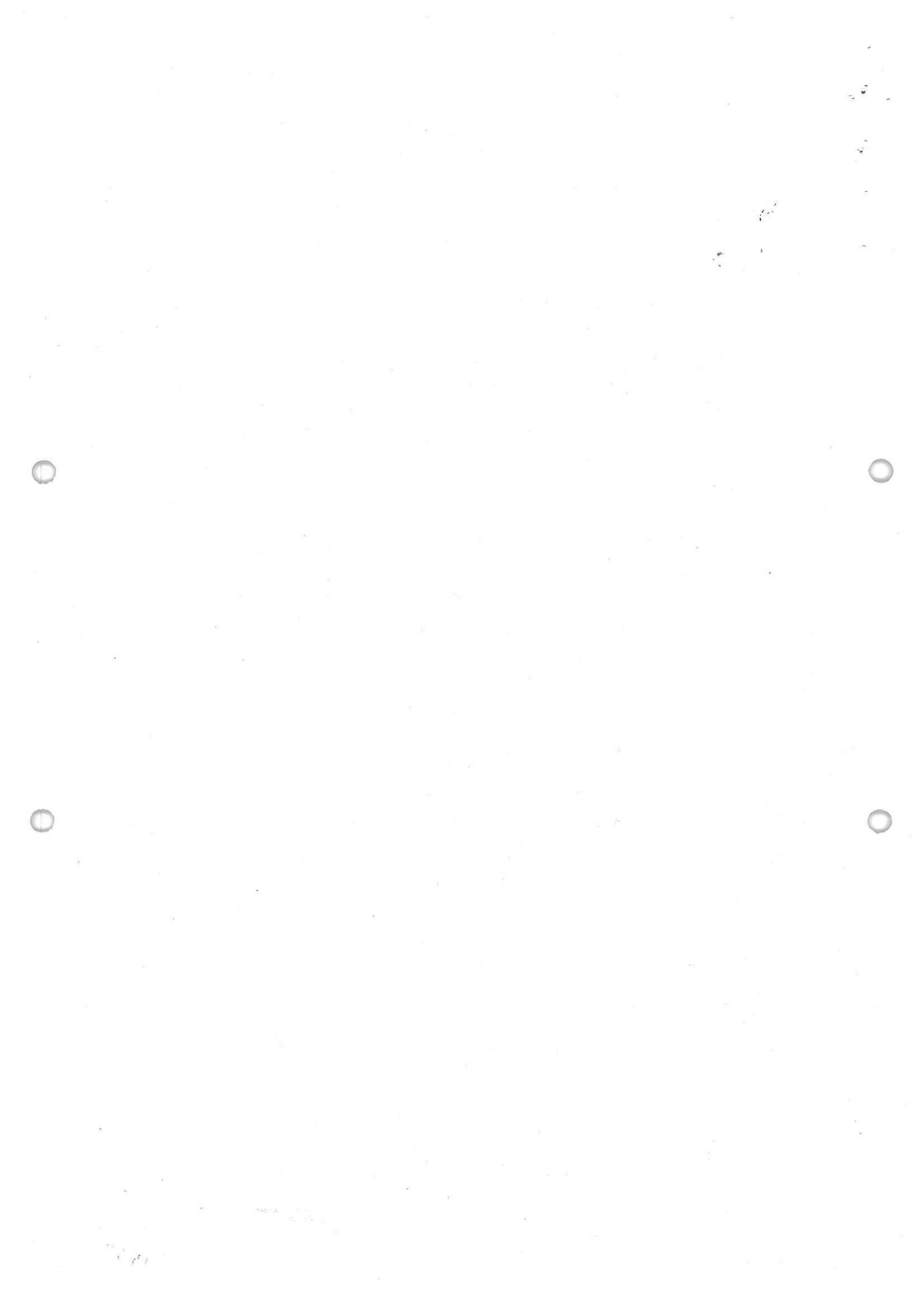
Details of Course:

Course Title	Course Structure			Pre-Requisite
MC408: Statistical Quality Control and Decision Making	L	T	P	Basic knowledge of probability and statistics
	3	1	0	

Course Objective: The objective of this course is to equip students with a foundational understanding of quality management principles and to provide practical skills in using Statistical Process Control (SPC) techniques for process improvement, decision-making, and production control, with an emphasis on statistical analysis and measurement tools.

Course Outcome (CO):

CO1	Identify and list the various elements associated with managing processes and products in connection to a particular industrial or engineering issue.
CO2	Assess and interpret data pertaining to process control.
CO3	Develop an effective sampling strategy to investigate and analyse issues related to industrial output based on the acquired data.
CO4	Examine the time series data and recommend an appropriate forecasting model to enhance resource management and offer valid solutions.
CO5	Evaluate industrial production models to align them with technological advancements, ensuring adaptability and efficiency in manufacturing processes.

S.No.	Contents	Contact Hours
UNIT 1	Introduction to statistical quality control (SQC), process control and product control. Tools for SQC. Control charts for variables. Control charts for attributes. Natural tolerance limits and specification limits.	8
UNIT 2	Acceptance sampling plans for attributes: Types of sampling plans. Single sampling plans, Double sampling plans, Multiple sampling plans and their comparison. Chain sampling plan and sequential sampling plan. Acceptance sampling plans for variables: Advantages and disadvantages, variable sampling plans for a process parameter and for estimating Lot Proportion Nonconforming	10
UNIT 3	Introduction to multiple regression: Developing and evaluating multiple regression models, Multiple regression residual analysis, Inferences about the population regression coefficients-Tests of hypothesis, Confidence interval estimation.	6
UNIT 4	Components and analysis of time series. Measurement of trend, seasonal variations and cyclic variations. Auto-regression series. Auto-correlation and correlogram. Choosing an appropriate forecasting model. Time series forecasting of seasonal data.	10
UNIT 5	Decision making. Pay off table. Decision trees. Maximax payoff, Maxmin payoff. Expected monetary value. Expected opportunity loss. Return-to-risk ratio. Decision making with sample information.	8
	TOTAL	42

Suggested Books:

S.No.	Name of Books/Authors/Publishers	Year of Publication
1	David M. Levine, David F. Stephen, and Kathryn A. Szabat, Statistics for Managers, 9th Edition, Pearson.	2019
2	Walpole, Myers, Myers, and Ye, Probability and Statistics for Engineers & Scientists, 9th Edition, Pearson.	2010
3	Douglas C. Montgomery, Introduction to Statistical Quality Control, John Wiley & Sons.	2008
4	C. Kahraman and S. Yanik, Intelligent Decision Making in Quality Management: Theory and Applications, First Edition, Springer.	2016
5	Introduction to Probability, Statistical Methods, Design of Experiments and Statistical Quality Control, D. Selvamuthu, D. Das, Second Edition, Springer.	2018
6	Amitava Mitra, Fundamentals of Quality Control and Improvement, 4th Edition, John Wiley & Sons.	2016

Details of Course:

Course Title	Course Structure			Pre-Requisite
MC409: Tensor Calculus	L	T	P	Basic knowledge of calculus, differential equations, vector calculus
	3	1	0	

Course Objective: This course provides an introduction to tensor calculus which is an essential tool for Applied Mathematician, Scientists and Engineers.

Course Outcome (CO):

CO1	Describe the basic concept of tensor algebra like transformation, summation convention, different type of tensors.
CO2	Describe Riemannian metric, fundamental tensor and hypersurfaces
CO3	Describe the Christoffel symbols, covariant derivatives and geodesics.
CO4	Describe Riemannian geometry, Riemannian -Christoffel tensor, Ricci tensor, Einstein tensor and Bianchi identities.
CO5	Describe advanced topic in general relativity and cosmology.

S.No.	Contents	Contact Hours
UNIT 1	**Tensor Algebra:** Generalized N- dimensional space, Transformation of coordinates, Definition of tensor, Summation convention, Invariants, Contravariant and Covariant tensors, Mixed tensor, Kronecker delta, Addition and Subtraction of tensors, Contraction, outer multiplication, Inner producttensors, Symmetric and skew-symmetric tensors, Quotient's law, Conjugate tensor.	10
UNIT 2	**Riemannian metric:** Riemannian metric, metric tensor, Length of a curve and null curve, Associated tensors, raising and lowering of indices, magnitude of vector, Levi-Civita tensor, Relative and absolute tensor, hypersurfaces, congruence of curves, Curvilinear Co-ordinates.	10
UNIT 3	**Tensor Calculus:** Christoffel symbols, properties and transformation laws of Christoffel symbols, Covariant differentiation of tensors, Gradient, divergence and curl, Geodesics, Null geodesics, Parallel transport.	8
UNIT 4	**Riemannian Geometry:** Riemann-Christoffel tensor, Riemannian curvature tensor and properties, Riemannian symbols of second kind, Covariant form, Ricci tensor, Scalar curvature, Bianchi identities, Einstein tensor, Weyl tensor, Bianchi identities,	8
UNIT 5	**Some advanced topics in tensor:** Lie derivative, killing vectors and equations, Applications to General Relativity and Cosmology.	6
	TOTAL	42

Suggested Books:

S. No.	Name of Books/Authors/Publishers	Year of Publication
1	A.J. Mc Connel, Application of Tensor analysis, Dover Publications	2011
2	J.L. Singe and A. Schild, Tensor Calculus, Dover Publications	1978
3	D. C. Aggarwal, Tensor Calculus and Riemannian Geometry, Krishna Prakashan.	1989
4	C.E. Weatherburn, Introduction of Riemannian Geometry and Tensor Calculus, Cambridge	2008
5	M. Dalarsson and N. Dalarsson, Tensor Calculus, Relativity and Cosmology, Elsevier	2005
6	S. Weinberg, Gravitation and Cosmology, Wiley Publication	2007
7	J.V. Narlikar, Introduction to General Relativity, Cambridge University Press, 1st Ed.	2012

Details of Course:

Course Title	Course Structure			Pre-Requisite
MC410: Game Theory	L	T	P	NIL
	3	1	0	

Course Objective: This course is intended to provide students with a comprehensive treatment of game theory with specific emphasis on applications in Economics and Engineering. The aim of this course is to introduce students to the novel concepts of Game Theory with special emphasis on its applications in diverse fields and current research.

Course Outcome (CO):

CO1	Identify the terminologies of game theory and solution concepts employed to predict the outcome of the game.
CO2	Analyze economic situations using game theoretic techniques.
CO3	Structure strategic problems as sequential and/or simultaneous games.
CO4	Identify the strategies to implement.
CO5	Apply the computing skill to formulate to solve real world problems.

S.No.	Contents	Contact Hours
UNIT 1	Two-Person Zero Sum Games Maximin and minimax criterion of optimality, Saddle point, Pure and mixed strategies, Dominance property.	8
UNIT 2	Solution Methods for Matrix Games, Algebraic method, Graphical method for solving 2×n and n×2 games, Invertible matrix games, Symmetric games, Linear Programming Method in Matrix Games.	9
UNIT 3	Two-Person Non-zero sum Games 2×2 Bimatrix Games, Interior Mixed Nash Points by Calculus, Nonlinear Programming Method for Nonzero Sum Two-Person Games	9
UNIT 4	Cooperative Game Theory, Coalitions and Characteristic Function, The Nucleolus, The Shaple Value, Bargaining	8
UNIT 5	N-Person Non-zero sum Games with a Continuum of Strategies. Economic Applications of Nash Equilibrium, Duels, Auctions – Complete Information	8
	TOTAL	**42**

Suggested Books:

S.No.	Name of Books/Authors/Publishers	Year of Publication
1	E.N. Barron, Game Theory: An Introduction, John Wiley & Sons.	2008
2	Osborne M.J., An Introduction to Game Theory, Oxford University Press.	2004
3	A. Mas-Colell, M.D. Whinston and J.R. Green, Microeconomic Theory, Oxford University Press.	1995
4	Auction Theory, V. Krishna, Second Edition, Academic Press Inc.	2009
5	Some Topics in Two-Person Games, T. Parthasarathy, T.E.S. Raghavan, American Elsevier Publishing Company.	1971
6	R.A. Gibbons, Primer in Game Theory, Pearson Education.	1992

Details of Course:

Course Title	Course Structure			Pre-Requisite
MC41I: Statistical Inference	L	T	P	A course in Statistics with sound knowledge of random variable, expectation and variance, m.g.f. and probability distribution.
	3	1	0	

Course Objective: The objective of the course is to understanding of various statistical parameters and type of estimation for analysis and predict and validate the claim by testing of hypothesis.

Course Outcome (CO):

CO1	Identify and analyze the characteristics of a good estimator.
CO2	Designing and testing of statistical hypothesis associated with the analysis of a problem of social/environmental/industrial interest.
CO3	Apply the skills of inference and testing for investigation of problems and providing valid conclusion for management of resources and finance .
CO4	Decide the distribution governing the phenomenon and analyse further for meaningful conclusion.
CO5	Apply the test to analyse the random process.

S.No.	Contents	Contact Hours
UNIT 1	Point and Interval Estimation, Characteristics of Estimators, Unbiasedness, Consistency, Efficiency, Sufficiency, Maximum Likelihood Estimation, Confidence Interval and Confidence Limits.	8
UNIT 2	Statistical Hypotheses, Critical Region, Two Types of Errors, Level of Significance, Power of the Test, Optimum Test Under Different Situation, Inference Concerning One Mean, Operating Characteristic Curves, Inference Concerning Two Means.	9
UNIT 3	Estimation of Variance, Hypothesis Concerning One and Two Variances. Estimation of Proportions, Hypothesis Concerning One and Several Proportions, Analysis of r×c Tables, Goodness of Fit.	9
UNIT 4	Least Square Estimator of the Regression Parameters, Statistical Inferences about the Regression Parameters, Curvilinear Regression, Multiple Regression, Coefficients of Determination and Correlation, Adequacy of the Model, Logistic Regression Models.	9
UNIT 5	Non Parametric Methods, Wald-Wolfowitz Run Test, Test for Randomness, Median Test, Sign Test.	7
	TOTAL	42

Suggested Books:

S.No.	Name of Books/Authors/Publishers	Year of Publication
1	Miller & Freund: Probability and Statistics For Engineers, Pearson Education.	2017
2	Sheldon M. Ross: Introduction to Probability and Statistics For Engineers and Scientists, Academic Press, 6e.	2020
3	Levine, Stephan & Szabat: Statistics for Managers, PHI Learning.	2014

Details of Course:

Course code: Course Title	Course Structure			Pre-Requisite
MC412: Information Theory and Coding	L	T	P	Probability and Statistics
	3	1	0	

Course Objective: This Course provide Design the channel performance using Information theory, comprehend various error control code properties, apply linear block codes for error detection and correction, apply convolution codes for performance analysis & cyclic codes for error detection and correction, design BCH & RS codes for Channel performance improvement against burst errors.

Course Outcome (CO):

CO1	Identify and measure the uncertainty associated with discrete random experiments to analyse and interpret the data.
CO2	Describe the theoretical model associated with the various blocks of the communication system to investigate the problems for suitable designing.
CO3	Analyze the constraints associated with the encoding/decoding of information sources to facilitate in finding the logical solutions.
CO4	List and design the various types of block codes suitable and analyze their errors detection and correction capabilities.
CO5	Reframe the generalized coding and decoding techniques and to correlate the theoretical models with the practical aspects.

S.No.	Contents	Contact Hours
UNIT 1	Discrete information sources, entropy, joint and conditional entropy, chain rule. Source coding, mapping functions and efficiency, mutual information, prefix codes, instantaneous decoding, construction of Huffman codes. Lempel-Ziv coding.	8
UNIT 2	Discrete memoryless channel model, transition probability matrix, channel capacity, symmetric channels. Block coding, equivocation. Entropy rate, channel-coding theorem. Markov chains and data processing.	9
UNIT 3	Data translation coding, prefix codes and block codes, fixed and variable length block codes, the Kraft inequality. Channel coding for error correction. Error rates and error distribution for the binary symmetric channel, Error detection and correction	9
UNIT 4	Maximum likelihood decoding principle. Linear block codes, Hamming weight, Hamming distance, and the Hamming cube. Syndrome decoders and the parity-check matrix.	8
UNIT 5	Cyclic codes, polynomial representation of cyclic codes, polynomial modulo arithmetic. Generator, parity-check, and syndrome polynomials. Systematic cyclic codes, the Hamming codes.	8
	TOTAL	42

Suggested Books:

S.No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	G.A. Jones and J.M. Jones, Information and Coding Theory, Springer Undergraduate Mathematics Series.	2000
2	W.C. Huffman and V. Pless, Fundamental of Error Correcting Codes, Cambridge University Press.	2010
3	R.B. Wells, Applied Coding and Information Theory for Engineers, Pearson Education.	1999
4	T.M. Cover and J.M. Thomas, Elements of Information Theory, Wiley Student Edition.	2006
5	Robert B. Ash, Information Theory, Dover Publications.	1990

Details of Course:

Course Title	Course Structure			Pre-Requisite
MC41 : Big Data Analytics	L	T	P	Database Management Systems
	3	0	2	

Course Objective: To understand the fundamentals of various big data analysis techniques, Hadoop structure, environment and framework.

Course Outcome (CO):

CO1	Define and explain Big Data Concepts.
CO2	Apply Big Data storage and processing techniques.
CO3	Apply Machine Learning techniques for Big Data analytics and evaluate their performances in large-scale data scenarios.
CO4	Design optimized workflows for performance and scalability. .
CO5	Develop an End-to-End Big Data Pipeline by Integrating its tools.

S.No.	Contents	Contact Hours
UNIT 1	**Introduction to Big Data:** Definition and Characteristics: 3Vs, 5Vs of Big Data, Evolution of Data and Data Growth Trends, Traditional Data Processing vs. Big Data Processing, Applications of Big Data in Various Industries, Challenges in Big Data Management, Types of Big Data: Structured, Semi-Structured, Unstructured, Big Data Processing Architectures: Batch Processing, Stream Processing.	8
UNIT 2	**Hadoop Environment:** Overview of the Hadoop Ecosystem, Hadoop Architecture, Components and examples - MapReduce Framework, Yet Another Resource Negotiator; Hadoop Distributed File System, Data Blocks, Replication, and Fault Tolerance, File Operations in HDFS, Data Ingestion in Hadoop: Sqoop, Flume.	10
UNIT 3	**Data Processing with MapReduce:** Introduction to MapReduce, Map and Reduce Phases, Writing MapReduce Programs. **Data Processing with Apache Spark:** Apache Spark Overview, Spark Core and Resilient Distributed Datasets, Spark SQL and Data Frames, Apache Hive for Structured Querying, fundamentals of HBase and ZooKeeper. **NoSQL Databases for Big Data**: Introduction to NoSQL, MongoDB: Document-based NoSQL, CRUD Operations, Indexing, Aggregation, Replication, Cassandra: Column-family NoSQL.	10
UNIT 4	**Machine Learning (ML) for Big Data:** Introduction to ML for Big Data, Scalable ML Frameworks, Deep Learning Techniques in Big Data, Overview of Real-time Big Data Processing, Streaming Data Sources: Kafka, Flume. Case Studies & Industry Applications of Big Data.	8
UNIT 5	**Big Data in Cloud:** Cloud service for Big data: AWS, Google Cloud, Azure; Amazon S3, Google BigQuery, Azure Data Lake, Serverless Computing for Big Data: AWS Lambda, Azure Functions.	6
	TOTAL	42

Suggested Books:

S.No.	Name of Books/Authors/Publishers	Year of Publication
1	White, T. *Hadoop: The definitive guide*. O'Reilly Media, 4th Edition, ISBN: 978-1491901632.	2015
2	Marz, N., & Warren, J. *Big data: Principles and best practices of scalable real-time data systems*. Manning Publications, 1st Edition, ISBN: 978-1617290343.	2015
3	Eaton, C., DeRoos, D., Deutsch, T., Lapis, G., & Zikopoulos, P. *Understanding Big Data: Analytics for Enterprise Class Hadoop and Streaming Data*. McGraw Hill Publishing, 7th Edition, ISBN: 978-0071790533.	2012
4	Wampler, D., Capriolo, E., & Rutherglen, J. *Programming Hive: Data warehouse and query language for Hadoop*. O'Reilly Media, 1st Edition, ISBN: 978-1449319335.	2012
5	Galeano, M. I. F. (2021). *Big data processing with Apache Spark*. Packt Publishing, 1st Edition, ISBN: 978-1800561466.	2021
6	Kulkarni, P. (2016). *Machine learning with big data*. Springer, 1st Edition, ISBN: 978-3319431608.	2016
7	Bahga, S., & Madisetti, V. (2014). *Cloud computing for big data: Principles and best practices*. CreateSpace Independent Publishing, 1st Edition, ISBN: 978-1494435141.	2014
8	Sbarski, P. *Serverless architectures on AWS*. Manning Publications, 1st Edition, ISBN: 978-1617293825.	2017

	PRACTICALS LIST
1	Write a program to set up a Hadoop in a single-node system and perform basic file operations like uploading a dataset to HDFS and retrieving and deleting files from HDFS.
2	Write a program to develop a simple MapReduce program to count word occurrences in a large text file. Also, compare the performance with and without MapReduce.
3	Write a program to perform the following tasks using Spark's Resilient Distributed Dataset and DataFrame API - - Load a CSV dataset into Spark. - Perform basic transformations (filter, map, reduce). - Execute SQL-like queries using Spark SQL. - Save processed data in different formats (CSV, Parquet).
4	Write a program to implement real-time data ingestion and processing.
5	Write NoSQL-based Insert, update, and retrieve operations to work with unstructured data using PyMongo.
6	Write a program to perform sentiment analysis on Twitter data using Spark MLlib and analyze the performance.
7	Write a program to build a recommendation engine for e-commerce using Apache Mahout.
8	Write a program to perform querying with structured data using Hive & SQL. Also, optimize the queries using partitions and bucketing.
9	Write a program to define a Workflow for cloud-based big data solutions.

Details of Course:

Course Title	Course Structure			Pre-Requisite
MC414: Natural Language Processing	L	T	P	Data Structures, Analysis and Design of Algorithms
	3	0	2	

Course Objective: Natural Language Processing aims to design computer programs to read, understand, and comprehend the text written in natural language.

Course Outcome (CO):

CO1	Describe the basic principles, techniques, and applications of Natural Language Processing tasks.
CO2	Model a natural language in a format that is understandable by the computer program
CO3	Describe approaches for syntax and semantic analysis of text.
CO4	Determine relevant information from the text.
CO5	Apply and analyze NLP techniques.

S.No.	Contents	Contact Hours
UNIT 1	**Introduction:** Introduction to NLP, Origins and History of NLP, Language Analysis, Phases in Language Analysis, Major Challenges of NLP, NLP and Machine Learning, Natural Language and Grammar, Applications of NLP, Tasks of NLP, Simple NLP Implementation Using Python.	8
UNIT 2	**Language Modeling:** Statistical Language Models, N-gram models, Smoothing Techniques, Maximum Likelihood Estimation, Markov Models, Hidden Markov Models, Continuous Space Models, Dimensionality Reduction using Latent Semantic Analysis, Word Embeddings, Grammar Based Language Models.	8
UNIT 3	**Lexical Analysis:** Initial Steps of Lexical Analysis: Tokenization, Stop Word Removal, Stemming, Lemmatization, Regular Expression, Finite State Automata, Morphological Analysis: Rule-based Morphological Analysis, Finite-State Transducers, Part-of-speech tagging: Rule-based POS Tagging, Machine Learning-Based Tagging, Hidden Markov Model (HMM) based POS tagging, Maximum Entropy (MaxEnt) Model, Brill Tagger, Spelling Error Detection and Correction: Dictionary Lookup Technique, N-gram Analysis Technique, Levenshtein Distance Method.	9
UNIT 4	**Syntactic Analysis:** Constituency - Phrase Level Constructions, Sentence Level Constructions, Context-free Grammar - Chomsky Normal Form, Greibach Normal Form, Probabilistic Context-Free Grammar (PCFG); Treebanks, Parsing-Top-down parsing, Bottom-up Parsing, Probabilistic Parsing: Introduction to Probabilistic parsing, Inside-Outside Algorithm for PCFGs, Viterbi Algorithm for PCFGs; Structural Ambiguity and Resolution, The Cocke–Younger–Kasami Algorithm.	9

UNIT 5	**Semantic Analysis:** Meaning Representation, Vector Space Models, Knowledge Graphs, Formal Representations of Meaning - Propositional Logic, First-Order Predicate Logic, Semantic Vector Models, Lexical Semantics, Semantic Ambiguity, Semantic relatedness, Similarity measures. **Tasks in NLP:** Word Sense Disambiguation, Machine Translation, Keyphrase Extraction, Advancements in NLP	8
	TOTAL	42

Suggested Books:

S.No.	Name of Books/Authors/Publishers	Year of Publication
1	Jurafsky, D., & Martin, J. H. *Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition with Language Models*. 3rd Edition	2024
2	Manning, C. D. *Foundations of Statistical Natural Language Processing*. MIT Press, ISBN: 978-0262133609.	1999
3	Tiwari, U. S., & Siddiqui, T. *Natural Language Processing and Information Retrieval*. Oxford University Press, ISBN: 978-0195692327.	2008
4	Allen, J. *Natural Language Understanding*. Pearson Education, ISBN: 978-0805303346.	2003
5	Bird, S., Klein, E., & Loper, E. *Natural Language Processing with Python: Analyzing Text with Natural Language Toolkit*. O'Reilly, ISBN: 978-0596516499.	2009

PRACTICALS LIST	
1	Implement a bigram language model using a given text corpus and calculate the probability of a given sentence.
2	Implement the Hidden Markov Model to tag parts of speech in a given text.
3	Implement the Levenshtein distance method in a given paragraph.
4	Build a PCFG using a small treebank of syntactically annotated sentences.
5	Implement the Path Length and Lin's similarity to compare the similarity between the words using WordNet.
6	Find top-k similar words using Word2Vec embeddings on a given text corpus.
7	Generate daily weather reports on collected data using weather API.
8	Fine-tune a pre-trained BERT model on a custom sentiment analysis dataset.
9	Extract keywords from a set of articles using TF-IDF or other statistical methods.
10	Predict the next word in a sequence of text data using an LSTM-based language model based on given prompts.

Details of Course:

Course Title	Course Structure			Pre-Requisite
MC415: Data Warehousing and Data Mining	L	T	P	Probability and Statistics Linear Algebra
	3	0	2	

Course Objective: To introduce the concept of Data Warehousing and Data Mining, respective techniques and applications in real-world scenario.

Course Outcome (CO):

CO1	Recall the fundamental concepts of data warehousing and data mining and basic data mining techniques.
CO2	Explain the design, implementation, and maintenance of data warehousing systems and association rule mining, classification, and prediction in data mining.
CO3	Apply data mining techniques to analyze large databases and extract meaningful insights.
CO4	Analyze and compare various data mining algorithms and their applications to different types of data, such as spatial, multimedia, and time-series data.
CO5	Evaluate the performance of data mining models and systems. Critique trends in data mining.

S.No.	Contents	Contact Hours
UNIT 1	**Data Warehousing:** Basic concepts in data warehousing, Collecting the requirements of data warehouse, Data Warehouse Architecture, Design, Implementation & Maintenance, OLAP in data warehouse, Data warehousing and the web, Data Cube Technology, From Data Warehousing to Data Mining.	8
UNIT 2	**Data Mining Concepts:** Data mining primitives, Basics of data mining, Query language, Architectures of data mining systems	8
UNIT 3	**Mining Association Rules in Large Databases:** Association Rule Mining, Mining Single Dimensional Boolean Association Rules from Transactional Databases, Mining Multilevel Association Rules from Transaction Databases, Mining Multidimensional Association Rules from Relational Databases and Data Warehouses, From Association Mining to Correlation Analysis, Constraint Based Association Mining.	9
UNIT 4	**Classification and Prediction:** Issues Regarding Classification and Prediction, Classification by Decision Tree Induction, Bayesian Classification, Classification by Back propagation, Classification Based on Concepts from Association Rule Mining, Other Classification Methods, Prediction, Classifier Accuracy.	8

UNIT 5	**Cluster Analysis in Data Mining:** Types of Data in Cluster Analysis. A Categorization of Major Clustering Methods, Partitioning Methods, Density Based Methods, Grid Based Methods, Model Based Clustering Methods, Outlier Analysis. Mining Complex Types of Data: Multidimensional Analysis and Descriptive Mining of Complex Data Objects, Mining Spatial Databases, Mining Multimedia Databases, Mining Time Series and Sequence Data, Mining Text Databases. **Applications and trends in Data Mining:** Applications, Systems products and research prototypes, Additional themes in data mining, Trends in Data mining, spatial mining, and Web Mining.	9
	Total	42

Suggested Books:

S.No.	Name of Books/Authors/Publishers	Year of Publication
1	Ponnian, P. *Data Warehousing Fundamentals*. John Wiley, ISBN: 978-0471412540.	2001
2	Dunham, M. H. *Data Mining: Introductory & Advanced Topics*. Pearson Education, ISBN: 978-0130888921.	2002
3	Han, J., & Kamber, M. *Data Mining: Concepts & Techniques*. Morgan Kaufmann, ISBN: 978-1558609013.	2006
4	Berry, M., & Linoff, G. *Mastering Data Mining*. John Wiley, ISBN: 978-0471331230.	2004

PRACTICALS LIST	
1	Write a program to implement the Apriori algorithm or use libraries like mlxtend to extract frequent itemsets and generate association rules. Set different support and confidence thresholds to generate rules. Use a dataset like the Groceries dataset or any other market basket dataset.
2	Write a program to implement the Apriori algorithm to mine rules at different levels of the hierarchy (e.g., category level, sub-category level).Use a dataset that contains multiple levels of categories (e.g., product categories).
3	Write a program to apply the Apriori or FP-Growth algorithm to mine multidimensional association rules.Use a multidimensional dataset (e.g., product, customer, region) from a relational database.
4	Write a program to analyze how these measures differ from support and confidence in determining interestingness. Use the association rules generated earlier, calculate the Lift, Conviction, and Leverage for each rule.
5	Write a program to implement or use a library (e.g., scikit-learn) to build a decision tree classifier. Evaluate the accuracy, precision, recall, and F1-score of the classifier. Use a dataset like the Iris dataset or a binary classification problem.
6	Write a program to implement the Naive Bayes algorithm using libraries like scikit-learn. Evaluate classifier accuracy and compare it with other classifiers. Use a dataset like SMS Spam Collection to classify messages as spam or ham.

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7	Write a program to build and train a neural network with multiple layers using a deep learning framework (e.g., TensorFlow, PyTorch). Compare the performance of the neural network with traditional methods like decision trees and Naive Bayes. Use a dataset like MNIST (handwritten digits) or Fashion MNIST for classification.
8	Write a program to implement multiple classifiers (e.g., K-Nearest Neighbors, Support Vector Machines, and Random Forest) on a dataset of your choice. Evaluate and compare the performance of these classifiers on the same dataset.
9	Write a program to implement both linear regression and decision tree regression to predict continuous outcomes. Compare the results of both models based on mean squared error and R-squared metrics. Use a dataset like house prices or weather data for a regression task.
10	Write a program to apply the K-Means clustering algorithm using scikit-learn and evaluate the clustering results. Implement the K-Medoids algorithm (e.g., using the PAM method) and compare its results with K-Means. Choose a dataset (e.g., Iris or Mall Customers).
11	Write a program to implement DBSCAN using scikit-learn and experiment with different parameters like eps and min_samples. Analyze the results to identify clusters and outliers. Use a dataset suitable for density-based clustering (e.g., circles or moons dataset).
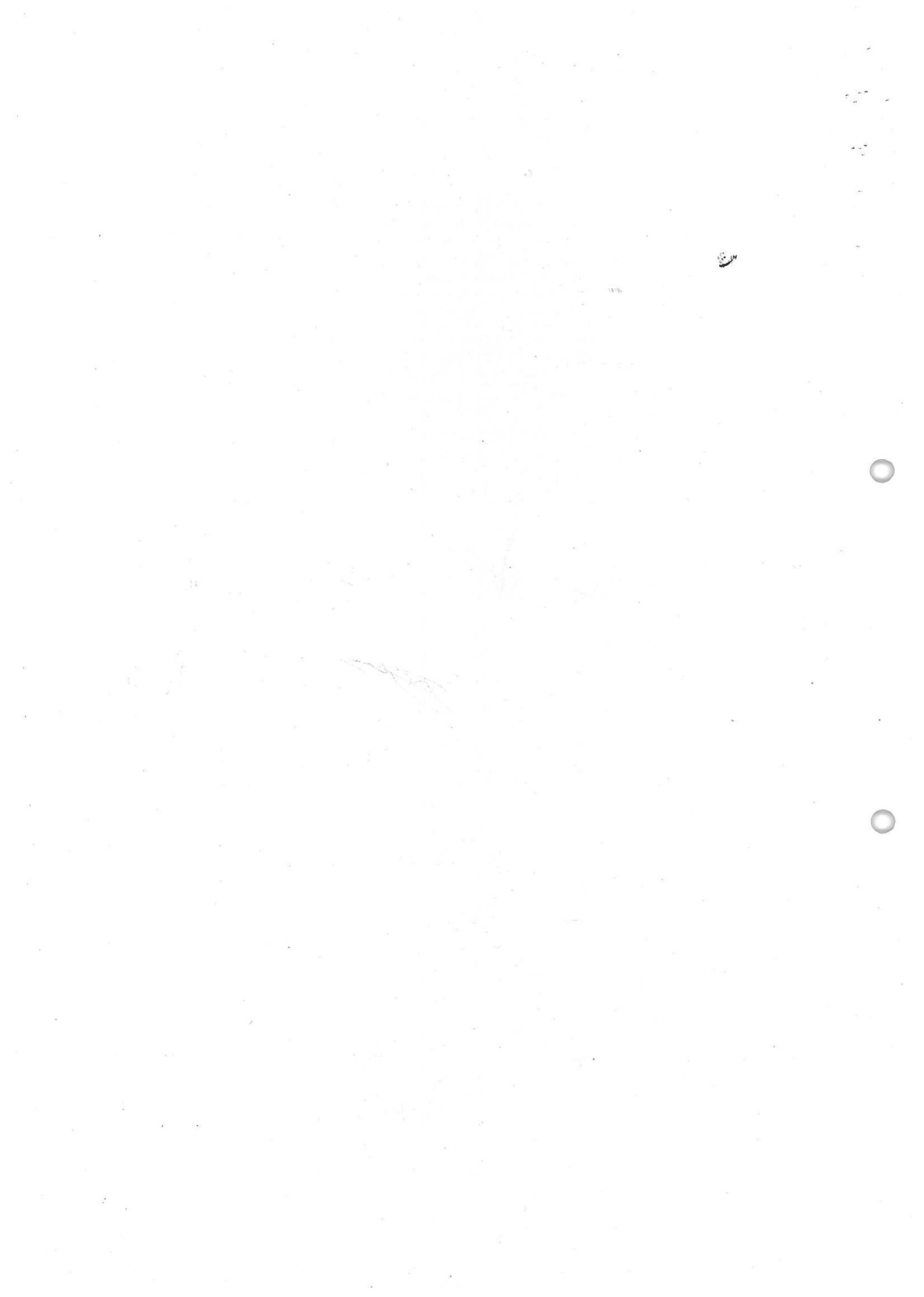
Details of Course:

Course Title	Course Structure			Pre-Requisite
MC417: Cryptography and Network Security	L	T	P	NIL
	3	1	0	

Course Objective: To explore various traditional and modern encryption algorithms, including key management and key exchange methods and study different authentication techniques and digital signature algorithms. The course also helps to understand network security protocols and strategies for protecting against network threats.

Course Outcome (CO):

CO1	Understand the various classical encryption techniques.
CO2	Describe, analyse, and apply modern block ciphers, public key cryptosystems and key exchange algorithms.
CO3	Explain and apply various message authentication algorithms and their applications.
CO4	Compare various key management policies and digital signature algorithms.
CO5	Elaborate the concept of IP security and web security and describe various security protocols (SSL, TLS, TSP, SET etc.), firewall and VPN.

S.No.	Contents	Contact Hours
UNIT 1	**Introduction to cryptography**, Introduction to Group, Rings and Fields, Euclidean algorithm: basic and extended, modular arithmetic classical encryption techniques: substitution ciphers and transposition ciphers, cryptanalysis, steganography, stream, and block ciphers.	8
UNIT 2	Modern block cipher principles, Shannon's theory of confusion and diffusion, feistel and non-feistel cipher structure, Data Encryption Standard (DES), strengths and weaknesses of DES, double and triple DES, International Data Encryption Algorithm (IDEA), Advanced Encryption Standard (AES).	8
UNIT 3	Fermat's and Euler's theorems, primality testing, chinese remainder theorem, discrete logarithm problem, principles of public key cryptosystems, RSA cryptosystem, security of RSA, key management, Diffie-Hellman key exchange algorithm, introductory idea of Elliptic curve cryptography, ElGamal encryption algorithm.	8
UNIT 4	Authentication requirement, authentication functions, Message Authentication Codes (MAC), Hash functions, message digest algorithm (MD5), Secure Hash Algorithm (SHA), Digital Signatures, authentication protocols, digital signature standards (DSS), proof of digital signature algorithm. **Authentication Applications:** Kerberos and X.509, directory authentication service, electronic mail security, pretty good privacy (PGP), S/MIME.	10

UNIT 5	**IP Security:** Architecture, Authentication header, encapsulating security payloads, combining security associations, key management. Web Security: Secure socket layer (SSL) and transport layer security (TLS), secure electronic transaction (SET), electronic money, WAP security, firewall design principles, virtual private network (VPN) security, Advanced attacks like DDoS, Zero-day attacks, etc.		8
		TOTAL	42

Suggested Books:

S.No.	Name of Books/Authors/Publishers	Year of Publication
1	Stallings, W. *Cryptography and Network Security: Principles and Practices*. Pearson Publication, 8th Edition, ISBN: 978-1292437484.	2023
2	Forouzan, B. A. *Cryptography and Network Security*. McGraw Hill Education, 3rd Edition, ISBN: 978-9339220945.	2015
3	Kahate, A. *Cryptography and Network Security*. McGraw Hill Education, 4th Edition, ISBN: 978-9353163303.	2019
4	Stinson, D. R. *Cryptography: Theory and Practice*. Chapman and Hall/CRC, 2nd Edition, ISBN: 978-1584882060.	2002

Details of Course:

Course Title	Course Structure			Pre-Requisite
MC419: Differential Geometry	L	T	P	Basic knowledge of calculus, differential equations, vector calculus, Linear Algebra
	3	1	0	

Course Objective: This course provides an introduction to differential geometry which describe the concept of curves and surfaces in space.

Course Outcome (CO):

CO1	Describe the basic concept of geometry of space curves, osculating plane, binormal and torsion.
CO2	Describe the concept of geometry of surfaces, geodesic curvature, first and second fundamental forms, edge of regression, developable surfaces.
CO3	Describe the curves on surface including Gauss curvature, Gauss-Weingarten formula, fundamental existence theorem on surfaces.
CO4	Describe geodesic and its properties, surface of revolution, geodesic polarco-ordinate, Bonnet theorem and formula.
CO5	Identify the global results about the surfaces.

S. No.	Contents	Contact Hours
UNIT 1	**Geometry of space curves**: Parametric representation of space curves, Arc length, Tangent vectors and vector fields in space, Tangent line, Osculating plane, Inflexion point, Normal plane, Principle normal, Binormal, Curvature and torsion, Fundamental theorem for space curves, Frenet-Serret formulae, Osculating circle, Osculating sphere, Spherical indicatrix, Frenet approximation.	9
UNIT 2	**Geometry of surfaces:** Parametrization, Arc length, Tangent plane, Differentials, First and Second fundamental forms, Curves in surfaces, Normal and geodesic curvature, Ruled surface, Developable surface, Edge of regression.	9
UNIT 3	**Curves on surface:** Gauss curvature, Gauss characteristic equation, Gauss and Weingarten formula, Mainardi-Codazzi equations, Fundamental existence theorem for surfaces, Parallel surfaces.	8
UNIT 4	**Geometry of Geodesic:** Geodesic, Geodesic property, Differential equation of geodesic, Surface of revolution, Torsion of geodesic, Geodesic polar co-ordinates, Normal property of geodesics, Bonnet's theorem, Bonnet's formula	8
UNIT 5	**Global result about surfaces:** The Gauss-Bonnet theorem, Theorem of parallels, Fundamental existence theorem for surfaces.	8
	TOTAL	42

Suggested Books:

S.No.	Name of Books/Authors/Publishers	Year of Publication
1	T.J. Willmore, An Introduction to Differential Geometry, Dover Publication	1997
2	Erwin Kreyszig, Differential Geometry, Dover Publication.	2003
3	Nirmala Prakash, Differential Geometry-An Integrated Approach, Tata McGraw Hill.	1981
4	D. Somasundaram, Differential Geometry, Narosa Publishing House	2004
5	B. O'Neil, Elementary Differential Geometry, Academic Press,2nd Ed.	2006
6	M.P. do Carmo, Differential Geometry of Curves and Surfaces, Dover Publication, 2nd Ed.	2016

Details of Course:

Course Title	Course Structure			Pre-Requisite
MC42 : Topology	L	T	P	NIL
	3	1	0	

Course Objective: The objective of the course is to impart knowledge of Topological Spaces, Connectedness, Compact Spaces, Countability axioms, etc.

Course Outcome (CO):

CO1	Describe topological spaces and their properties.
CO2	Analyze and prove properties of subspaces and relative topologies, including their relationships with the parent topological space and their topological properties.
CO3	Integrate different concepts of topology like continuity, connectedness, components, etc. in an effective manner to arrive at new and innovative concepts.
CO4	Explain the concepts of compactness, countability axioms and separation axioms and relate them.
CO5	Illustrate how topological properties such as compactness, connectedness, and continuity behave in product spaces, and being able to prove basic results related to these properties.

S.No.	Contents	Contact Hours
UNIT 1	Topological Spaces, The order topology, Local Base at a point, Base for a Topology, Limit points, Interior, Exterior and Frontier points, Separable Spaces, Subspaces.	9
UNIT 2	Continuity, Homeomorphism, Separated sets, Connectedness, Components, Locally Connected Space.	8
UNIT 3	Compact spaces, Compactness in R, Countable Compactness, Local Compactness, One Point Compactification.	7
UNIT 4	Countability axioms, Separation axioms, Urysohn's Lemma, Urysohn's metrization theorem, Tietze extension theorem.	10
UNIT 5	Product Space of two Spaces, General Product Spaces (Tychonoff Topology), Product Invariant Properties, Tychonoff Theorem, Stone-Cech compactification.	8
	TOTAL	42

Suggested Books:

S.No.	Name of Books/Authors/Publishers	Year of Publication
1.	G.F. Simmons Introduction to Topology and Modern analysis, G. McGraw Hill International Edition	1963
2.	James R. Munkres, Topology, Second edition, Prentice Hall of India	2000
3.	S.T. Hu, Elements of General topology, Holden-Day Inc 1964	1964
4.	J.G. Hocking and G.S. Young, Topology, Addison-Wesley 1961	1961

Details of Course:

Course Title	Course Structure			Pre-Requisite
MC42₃: Functional Analysis	L	T	P	Linear Algebra, Real Analysis
	3	1	0	

Course Objective: The objective of this course is to impart knowledge of different spaces such as Normed linear spaces, Banach spaces and Hilbert spaces. It also includes all the important theorems, with applications, in the theory of Banach and Hilbert spaces.

Course Outcome (CO):

CO1	Analyze how ideas from different areas of mathematics in line with functional analysis combined to produce new concepts that are more effective than existing ones.
CO2	Apply the logical skills developed in various computer applications.
CO3	Describe and apply the theory of linear operators on a Hilbert space, including adjoint operators, self-adjoint and unitary operators with their spectra to evolve innovative modals.
CO4	Formulate, solve and analyze interdisciplinary real-world problems for higher study and research.
CO5	Demonstrate an understanding of all new concepts and proofs of the theorems.

S.No.	Contents	Contact Hours
UNIT 1	Metric spaces: Definition and examples, Holder inequality and Minkowsky inequality, Separable metric spaces, Convergence, Cauchy sequence, Completeness, Complete and Incomplete metric spaces with examples, Completion of metric spaces.	9
UNIT 2	Linear spaces, Linear independence, basis and dimension, Normed linear spaces, Examples, Schwarz inequality, Banach spaces, Spaces and Subspaces of finite dimensions, Convex sets in Normed linear spaces, Quotient spaces.	9
UNIT 3	Linear operators, basic classes of linear operators, Elementary properties of linear operators, Linear operators in finite dimensional spaces, Spaces of continuous linear operators, Spectrum of a bounded and self adjoint operator, Spectrum of a completely continuous operators	8
UNIT 4	Linear functionals, Hahn-Banach theorem, Conjugate spaces, Uniform boundedness principle, Strong convergence of sequence of operators, Weak convergence of sequence of functionals.	8
UNIT 5	Inner product spaces, properties of inner product spaces, Hilbert spaces, Examples, Orthogonality, Orthonormality, Riesz representation theorem.	8
	TOTAL	42

Suggested Books:

S.No.	Name of Books/Authors/Publishers	Year of Publication
1.	B. K. Lahiri; Elements of Functional Analysis, World Press	2005
2.	John B Conway; A course in Functional Analysis, Springer New York	2019
3.	Walter Rudin; Functional Analysis, McGraw Hill Education	2017
4.	E. Kreyszig; Introductory Functional Analysis with Applications, John Wiley & Sons	1989
5.	M. Thamban Nair; Functional Analysis: A First Course, PHI Learning	2021

Details of Course:

Course Title	Course Structure			Pre-Requisite
MC425: Compiler Design	L	T	P	NIL
	3	1	0	

Course Objective: To study the design of all the phases of the compiler in detail.

Course Outcome (CO):

CO1	Explain the phases and structure of a typical compiler.
CO2	Identify lexical tokens of any programming language and design and implement a lexical analyzer for the same.
CO3	Describe the role of a parser in a compiler and design and compare the performance and design trade-offs of various parsers.
CO4	Demonstrate a semantic analyzer and create a syntax-directed definition and an annotated parse tree.
CO5	Design and implement an intermediate code generator based on given code patterns.

S.No.	Contents	Contact Hours
UNIT 1	**Introduction:** Definition , Phases and Passes, Finite State Machines, Regular Expressions and their application to Lexical Analysis, Implementation of Lexical Analyzers, Lexical- Analyzer Generator, Lex – Compiler.	6
UNIT 2	**Syntax Analysis:** Formal Grammar and their application to Syntax Analysis, BNF Notation, Syntactic specification of Languages: CFG, Derivation and Parse Trees, Shift Reduce Parsing, Operator precedence parsing, top down Parsing, Predictive Parsers.	7
UNIT 3	**Parsers:** LR Parsers, the canonical collection of LR(0)items, constructing SLR Parsing Tables, Constructing canonical LR Parsing tables and LALR parsing tables , An Automatic Parser Generator, YACC.	7
UNIT 4	**Syntax Directed Translation:** Syntax directed Translation Schemes, Implementation of Syntax directed translators, Intermediate Code, Postfix notation, Parse Trees and Syntax Trees, Three address Code, Quadruple & Triples, Translation of Assignment Statements, Boolean expressions, Control Statements, Array Reference Books in Arithmetic expressions , Procedure Calls , Declarations and Case statements Translations.	8
UNIT 5	**Symbol Tables:** Data Structure for Symbol Tables, representing scope information.Run Time Administration: Implementation of simple Stack allocation scheme, storage allocation in block structured language.	7
UNIT 6	**Error detection and Recovery:** Lexical phase errors,syntax phase errors,semantic errors.And Error recovery techniques, Code Optimization: Loop optimization, the DAG representation of basic blocks, value numbers and Algebraic Laws, Global Data – Flow Analysis and Code generation.	7
	TOTAL	42

Suggested Books:

S.No.	Name of Books/Authors/Publishers	Year of Publication
1	Aho, A. V., Lam, M. S., Sethi, R., & Ullman, J. D. *Compilers: Principles, Techniques, and Tools*. 2nd Edition, Addison Wesley, ISBN: 978-0321486813.	2006
2	Dhamdhere, D. M. *Compiler Construction: Principles and Practice*. 2nd Edition, Macmillan India, ISBN: 978-0333904060.	1997