AMITY UNIVERSITY RAJASTHAN

Amity Directorate of Online Education

Master of Science (Mathematics)

AMITY UNIVERSITY RAJASTHAN

Amity Directorate of Online Education

Master of Science (Mathematics)

Programme Code: 121315

Duration – 2 Years Online

Batch 2024-26

Scheme and Syllabus

AMITY UNIVERSITY RAJASTHAN

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Program Outcomes		
MASTER OF SCIENCE (Mathematics)		
S. No.	**Description**	**POs**
1.	To be able to analyze problems, formulate hypotheses, evaluate, and validate results; acquire the capacity to extrapolate from what one has learned and apply the competencies to solve different kinds of non-familiar problems.	**PO1**
2	To acquire relevant knowledge and skills appropriate to professional activities and demonstrate the highest standards of ethics in the subject concerned: identify unethical behavior, and plagiarism and acquire knowledge of plagiarism tools.	**PO2**
3	To develop analytical reasoning and to evaluate the reliability and relevance of scientific evidence; acquire logical thinking; analyze and synthesize data from a variety of sources with valid interpretations and conclusions.	**PO3**

Program Education Objectives (PEOs):

PEO 1 To relate the knowledge of mathematical ideas in interdisciplinary fields.

PEO 2 To realize the nature of abstract mathematics and look at the concepts in further detail.

PEO 3 To analyze the real-world problems mathematically find the appropriate solutions and interpret the results.

PEO 4 To inculcate a sense of logical thinking.

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Credits PG (2 years/ 4 semesters) PG						
Semester	**Core (CC)**	**Domain Electives (DE)**	**Open Electives (OE)**	**VAC**	**NTCC**	**Total**
I	4*5	0	0	1*4	0	24
II	4*5	1*5	0	0	0	25
III	3*5	1*5	0	0	1*10	30
IV	0	0	0	0	1*27	27
Total	**55**	**10**	**0**	**4**	**37**	**106**

Note: - CC - Core Course, VAC - Value Added Course, OE - Open Elective, DE - Domain Elective

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FIRST SEMESTER

Code	Course	Category	L	T	P	Credits
MAM 101	Complex Analysis	CC	4	1	-	5
MAM 102	Real Analysis	CC	4	1	-	5
MAM 103	Advanced Differential Equation	CC	4	1	-	5
MAM104	Probability Theory & Statistics	CC	4	1	-	5
Value Added Courses						
BCS108	Professional Communication	VA	4	-	-	4
	Total					24

SECOND SEMESTER

Code	Course	Category	L	T	P	Credits
MAM 201	Advanced Abstract Algebra & Linear Algebra	CC	4	1	-	5
MAM 203	Optimization Techniques	CC	4	1	-	5
MAM 204	Statistical Methods	CC	4	1	-	5
MAM 210	Special Functions and Transform Calculus	CC	4	1	-	5
DE Electives: Student has to select 1 course from the list of following DE electives						
MAM 202	Numerical Methods & Data Analysis	DE	4	1	-	5
MAM 207	Topology					
	Total					25

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THIRD SEMESTER

Code	Course	Category	L	T	P	Credits
MAM 301	Mathematical Modeling	CC	4	1	-	5
MAM 303	Discrete Mathematical Structures	CC	4	1	-	5
MAM 305	Partial Differential Equation	CC	4	1	-	5
MAM350	Summer Internship (Evaluation)	CC	-	-	-	10
DE Electives: Student has to select 1 course from the list of following DE electives						
MAM 304	Mathematical Methods	DE	4	1	-	5
MAM 309	Lebesgue Measure Theory					
	Total					30

FOURTH SEMESTER

Code	Course	Category	L	T	P	Credits
MAM 460	Project	CC	-	-	-	27
	Total					27

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FIRST SEMESTER

COMPLEX ANALYSIS

COURSE CODE	CREDIT UNITS	CE Marks	ETE Marks	Total Marks
MAM101	5	30	70	100

Course Objective:
The objective of this course module is to acquaint the students with the mathematics involved in the basics of complex numbers, analytic function, complex integration, and open mapping theorem and to get them familiar with various important applications in evaluating real integrals.

Course Contents:

Module I
Review of complex numbers; Analytic functions, harmonic functions, elementary functions, branches of multiple-valued functions.

Module II
Conformal mappings; Complex integration, Cauchy's integral theorem, Cauchy's integral formula.

Module III
Theorems of Morera and Liouville, maximum-modulus theorem; Power series, Taylor's theorem, and analytic continuation.

Module IV
Zeros of analytic functions, open mapping theorem; Singularities, Laurent's theorem, Casorati - Weierstrass theorem, argument principle, Rouche's theorem, Cauchy's residue theorem and its applications in evaluating real integrals, Mittag-Leffler's theorem.

Module V
Bilinear transformation, Riemann mapping theorem, infinite products, Beta - Gamma function and its properties, functional equation for Beta and Gamma function, integral version of Beta & Gamma functions, Jensen formula, Poisson-Jensen formula.

Text & References:

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Text:

- R.V. Churchill and J.W. Brown, Complex Variables and Applications, 5th edition, McGraw Hill, 1990.
- J. H. Mathews and R. W. Howell, Complex Analysis for Mathematics and Engineering, 3rd edition, Narosa.
- Conway, .I.B., Functions of One complex variable Narosa Publishing, 2000.
- Ahlfors, L.V., Complex Analysis. McGraw-Hill Book Company, 1979.

References:

- L. V. Ahlfors, Complex Analysis, 3rd Edn., McGraw Hill, 1979.
- J. E. Marsden and M. J. Hoffman, Basic complex analysis, 3rd Edn., W. H. Freeman, 1999.
- Priestly, HA., Introduction to Complex Analysis Claredon Press, Orford, 1990.
- Liang-shin Hann & Bernard Epstein, Classical Complex Analysis, Jones and Bartlett Publishers International, London, 1996.
- D.Sarason, Complex Function Theory, Hindustan Book Agency, Delhi, 1994.
- Mark J.Ablewitz and A.S.Fokas, Complex Variables: Introduction & Applications, Cambridge University Press, South Asian Edition, 1998.
- E.C.Titchmarsn, The Theory *of* Functions, Oxford University Press, London.
- S.Ponnusamy, Foundations of Complex Analysis, Narosa Publishing House, 1997.

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REAL ANALYSIS

COURSE CODE	CREDIT UNITS	CE Marks	ETE Marks	Total Marks
MAM102	5	30	70	100

Course Objective:

The module aims to introduce the students to the fundamental ideas of Real Analysis: limits of sequences, infinite series, limits of real functions, continuity, differentiability, and the Riemann integral. The module should encourage students to think clearly and critically and to begin to be able to prove simple statements on their own.

Course Contents:

Module I

Sequences and series of functions, Pointwise and uniform convergence, Cauchy criterion for uniform convergence, Uniform convergence and continuity, Uniform convergence, and differentiation, Weierstrass approximation theorem.

Module II

Set functions, intuitive idea of measure, Elementary properties of measure, Measurable sets and their fundamental properties. Lebesgue measure of sets of real numbers, Algebra of measurable sets; Borel sets, Equivalent formulation of measurable sets in terms of open, Closed, Fo and Gs sets, "Non measurable sets.

Module III

Measurable functions and their equivalent formulations, Properties of measurable functions. Approximation of measurable functions by sequences of simple functions, Measurable functions as nearly continuous functions, Egoroff s theorem, Lusin's theorem, Convergence in measure and F Riesz theorem for convergence in measure. Almost uniform convergence.

Module IV

Shortcomings of Riemann Integral, Lebesgue Integral of a bounded function over a set of finite measure and its properties. Lebesgue integral as a generalization of Reimann integral, Bounded - convergence theorem, Lebesgue theorem regarding points of discontinuities of Riemann integral. functions, Integral of non-negative functions, Fatou's Lemma, Monotone convergence-" Theorem, Geaeral Lebesgue Integral, Lebesgue convergence theorem.

Text & References:

***Text*:**

- J. E. Marsden and M. J. Hoffman, Elementary Classical Analysis, 2nd Edn., W. H. Freeman, 1993.

- W. Rudin, Principles of Mathematical Analysis, 3rd Edn., McGraw Hill, 1976.

References:

- P. M. Fitzpatrick, Advanced Calculus, 2nd Edn., AMS, Indian Edition, 2010.
- N. L. Carothers, Real Analysis, Cambridge University Press, Indian Edition, 2009.

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ADVANCED DIFFERENTIAL EQUATIONS

COURSE CODE	CREDIT UNITS	CE Marks	ETE Marks	Total Marks
MAM 103	5	30	70	100

Course Objective:

In this course, we will study differential equations as mathematical descriptions of situations that arise in science and engineering. We will learn how to find the exact solution of some equations, but we will see that this is not always possible or practical. In these cases, we will learn to extract information about the behavior of a solution from the differential equation itself. We will also study some simple techniques to find numerical approximations of solutions.

Course Contents:

Module I

Review of fundamentals of Differential equations (ODEs); Existence and uniqueness theorems. Power series solutions, Systems of Linear ODEs, Stability of linear systems.

Module II: Cell Organelles

Initial value problem and equivalent integral equation, e-approximate solution, equicontinuous set of functions. Ascoli- Arzela theorem, Cauchy -Peano existence theorem and its corollary. Lipschitz condition. Differential inequalities and uniqueness - Gronwall's inequality: Successive approximations. Picard-Lindelof theorem. Continuation of solution Maximal interval of existence , Extension theorem. Kenser'stheorem(statement only).

Module III

Linear differential systems: Definitions and notations. Linear homogeneous systems; Fundamental matrix, Adjoint systems, reduction to smaller homogeneous systems. Non-homogeneous linear systems; variation of constants. Linear systems with constant coefficients. Linear systems with periodic coefficients. Floquet theory.

Module IV

Higher order equations: Linear differential equation (LDE) of order 'n', Linear combinations, Linear dependence, and linear independence of solutions. Wronskian theory: Definition, a necessary and sufficient condition for linear dependence and linear independence of solutions of homogeneous LDE. Abel's identity, Fundamental set, More Wronskian theory. Reduction of order. Non-homogeneous LDE. Variation of parameters. Adjoint equations, Lagrange's Identity, Green's formula. Linear equation of order n with constant coefficients.

Module V

System of differential equations, the n-th order equation, dependence of solutions on initial conditions and parameters. Maximal and Minimal solutions. Differential inequalities. A theorem of Wintner. Uniqueness theorems: Kamke's theorem, Nagumo's theorem, and Osgood's theorem.

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Text & References:

***Text*:**

- E.A. Coddington and N. Levinson, *Theory of Ordinary Differential Equations*, Tata McGraw-Hill, 2000.
- P. Hartman, *Ordinary Differential Equations*, John Wiley & Sons NY, 1971.

References:

- S.L. Ross, Differential Equations, John Wiley & Sons,
- G. Birkhoff and G.C. Rota, Ordinary Differential Equations, John Wiley & Sons,1978.
- G.F. Simmons, Differential Equations, Tata McGraw-Hill, 1993.
- I.G. Petrovski, Ordinary Differential Equations, Prentice-Hall, 1966.
- D. Somasundaram, Ordinary Differential Equations, A First Course, Narosa Pub., 2001.
- S.G. Deo, V. Lakshmikantham and V. Raghavendra, Textbook of Ordinary Differential Equations, Tata McGraw-Hill, 2006.

PROBABILITY & STATISTICS

COURSE CODE	CREDIT UNITS	CE Marks	ETE Marks	Total Marks
MAM104	5	30	70	100

Course Objective:

This course aims to introduce the concept of probability as quantified uncertainty, to give a critique of the frequentist interpretation of probability, and to provide the basic knowledge necessary to pursue further study in probability and statistics.

Course Contents:

Module I

Axiomatic definition of probability, probability spaces, probability measures on countable and uncountable spaces, conditional probability, and independence.

Module II

Random variables, distribution functions, probability mass and density functions, functions of random variables, standard univariate discrete and continuous distributions, and their properties; Mathematical expectations, moments, moment generating functions, characteristic functions, inequalities.

Module III

Random vectors, joint, marginal, and conditional distributions, conditional expectations, independence, covariance, correlation, standard multivariate distributions, and functions of random vectors.

Module IV
Modes of convergence of sequences of random variables, weak and strong laws of large numbers, central limit theorems; Introduction to stochastic processes, definitions, and examples.

Module V
Tests of significance, Hypothesis testing, large samples, Small samples, Chi-square test.

Text & References:

***Text*:**

- J. Jacod and P. Protter, Probability Essentials, Springer, 2004.
- V. K. Rohatgi and A. K. Md. E. Saleh, An Introduction to Probability and Statistics, 2nd Edn., Wiley, 2001.

References:

- P. G. Hoel, S. C. Port and C. J. Stone, Introduction to Probability Theory, Universal Book Stall, 2000.
- G. R. Grimmett and D. R. Stirzaker, Probability and Random Processes, 3rd Edn., Oxford University Press, 2001.
- S. Ross, A First Course in Probability, 6th Edn., Pearson, 2002.
- W. Feller, An Introduction to Probability Theory and its Applications, Vol. 1, 3rd Edn., Wiley, 1968.
- J. Rosenthal, A First Look at Rigorous Probability Theory, 2nd Edn., World Scientific, 2006.

Professional Communication

COURSE CODE	CREDIT UNITS	CE Marks	ETE Marks	Total Marks
BC108	4	30	70	100

Course Objectives:

The objective of this course is to enable students to:

1. Develop a comprehensive understanding of communication and its application in different contexts.
2. Discuss the processes of communication.
3. Analyze and discuss different types of business correspondence.
4. Develop skills in written as well as oral communication.

Learning Outcomes:

Upon successful completion of the course, students will be able to:

1. Develop a comprehensive understanding of communication and its application in different contexts.
2. Discuss the processes of communication.
3. Analyze and discuss different types of business correspondence.
4. Develop skills in written as well as oral communication.

Module I

Verbal and Nonverbal Communication

Oral Communication: forms, advantages, and disadvantages; Written Communication: forms, advantages, and disadvantages; Principles and Significance of Nonverbal communication, KOPPACT (Kinesics, Oculesics, Proxemics, Paralinguistics, Artifactics, Chronemics, Tactilics

Module II

Social Communication Essentials and Cross-Cultural Communication

Small talk, building rapport, Informal Communication; Public speaking in multi-cultural context, Culture and Context, Ethnocentrism, stereotyping, cultural relativism, Cultural shock, and social change.

Module III

Meetings

Meetings: Meaning and Importance, Purpose of Meeting, Steps in conducting the meeting, Written documents related to meeting: Notice, Agenda, Minutes

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Module IV

Report Writing

Types of Report, Significance of Reports, Report Planning, Process of Report Writing, Visual Aids in Reports

Module V

Employment Communication

Cover Letter, Resume, participating in a Group Discussion, Preparing for an interview, Appearing in an interview

Text & References:

Text:

- Essentials of Management, H. Koontz
- Principles and Practices of Management, Bakshi
- Student Study Material (SSM)

References:

- Management, Stoner, Freemand& Gilbert
- Principles & Practices of Management, L.M. Prasad / C.B. Gupta
- Management Today, Burton & Thakur

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SECOND SEMESTER

ADVANCED ABSTRACT ALGEBRA

COURSE CODE	CREDIT UNITS	CE Marks	ETE Marks	Total Marks
MAM201	5	30	70	100

Course Objective:

The concepts and results of Algebra are fundamental to the study of Mathematics and represent a human achievement of great beauty and power. It is a core topic for all disciplines that use higher mathematics and logic. The purpose of this course is to develop the theory and properties of some fundamental algebraic structures of groups, rings modules, and fields.

Course Contents:

Module I

Normal groups, quotient groups, Class equation of groups, Groups of order < 10, Cauchy's Theorems for abelian and non–abelian groups, Sylow's Theorems for abelian and non–abelian groups, solvable groups, the symmetric group S_n for $n > 4$ is not solvable, Maximal subgroups, composition Series of a group, Jordan Holder Theorem.

Module II

Overview of Rings and Fields, Integral Domains, Euclidean domains, Unique Factorization domains, Modules, Definition and examples, Direct sum, Free modules, Quotient modules, Simple modules, Modules over Principle ideal domains, Modules with chain conditions, Artenian Modules, Noetherian Modules, Hilbert's basis theorem

Module III

Overview of vector spaces, Extension of Fields, Finite Extension of a field, Algebraic and transcendental extensions of a field, roots of a polynomial, Existence of a root of an irreducible polynomial in some extension, splitting fields, Separable and inseparable extensions, Normal extension of a field.

Module IV

Linear operators and matrices Similarity of linear transformations. Invariant subspaces. Reduction to triangular forms. Nilpotent transformation. Index of nilpotency. Invariants of a nilpotent transformation. The primary decomposition theorem.

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Text & References:

- N. Herstein, Topics in Algebra, John Wiley & Sons, Singapore
- C. Musili, Introduction to Rings and Modules, Narosa Publishing House, New Delhi
- P. B. Bhattacharya, S.K. Nagpaul, Basic Abstract Algebra (2nd Ed.), Cambridge University Press, Indian Edition, 1997.
- M. Artin, Algebra, Prentice Hall of India, New Delhi.
- N. Jacobson, Basic Algebra (Vols. I & II), W.H. Freeman. 1980
- S. Lang, ALGEBRA 3rd Edition, Pearson Education Asia, New Delhi
- S. Luther and IBS Passi, Algebra (Vols I & II), Narosa Publishing House, New Delhi
- S. Singh and Q. Zameeruddin, Modern Algebra, New Age Publishers, New Delhi.

OPTIMIZATION TECHNIQUES

COURSE CODE	CREDIT UNITS	CE Marks	ETE Marks	Total Marks
MAM 203	5	30	70	100

Course Objective:

The problems in optimization are the most common applications of mathematics. The main aim of this course is to present different methods of solving optimization problems in the areas of linear programming, nonlinear programming, and integer linear programming. In addition to theoretical treatments, there will be some introduction to numerical methods for optimization problems**.**

Course Contents:

Module I: Linear Programming Problems (LPP)

Definition of LPP, Graphical Solutions of Linear Programming Problems, Simplex Method, and Artificial Variable Method, Two Phase Method, Charnes' Big M method. Sensitivity Analysis, Revised Simplex Method, Duality, Dual Simplex Method

Module II: Transportation Problems

Introduction to Transportation Model, Matrix Form of TP, Basic Feasible Solution of a TP, Degeneracy in TP, Formation of Loops in TP, Solution Techniques of TP, Different Methods for Obtaining Initial Basic Feasible Solutions viz. Matrix Minima Method, Row Minima Method, Column Minima Methods, Vogel's Approximation Method, Techniques for Obtaining Optimal Basic Feasible Solution.

Assignment Problems: Definition, Hungarian Method for AP.

Module III: Integer Linear Programming Problems

Integer Linear Programming Problems, Mixed Integer Linear Programming Problems, Cutting Plane Method, Branch and Bound Method

Module IV: Dynamic Programming
Bellman's Principle of Optimality of Dynamic Programming, Multistage decision problem and its solution by Dynamic Programming with finite number of stages, Solution of linear programming problems as a Dynamic Programming problem.

Text & References:

- Hadley, G.," Linear Programming,", Addison-Wesley, Mass.
- H.A.Taha," Operations Research – An Introduction", Macmillian
- F.S. Hiller, G.J. Lieberman," Introduction to Operations Research", Holden-Day
- 4. Harvey M. Wagner, "Principles of Operations Research with Applications to Managerial Decisions", Prentice Hall of India Pvt. Ltd.
- K. Swarup, P. K. Gupta and Man Mohan, "Operation Research", Sultan Chand & Sons, New Delhi

STATISTICAL METHODS

COURSE CODE	CREDIT UNITS	CE Marks	ETE Marks	Total Marks
MAM 204	5	30	70	100

Course Objective:

This course aims to provide basic ideas of probability probability distribution theory, and statistical Inference to the student understand the principles and methods of statistics regression, and to analyze numerical data and draw inferences.

Course Contents:

Module I: Probability & Probability Distributions

Classical and Modern axiomatic definition of probability, Addition and Multiplication rule of probability, Testing the independence of events, Random variables and probability Distribution, Conditional probability, Baye's Theorem, Discrete and Continuous Distribution, Moment

Generating Functions, Binomial distribution, Poisson distribution, Negative Binomial distribution, Exponential distribution, and Normal Distribution.

Module II: Statistical Methodology

Theory of sampling, different methods of sampling: Random sampling, stratified sampling, cluster sampling, systematic sampling, etc. Distribution of sample mean and variance, Test of significance: normal, t, Chi-square, F-test and Analysis of variance – one-way classification.

Module III: Elementary Statistical Inference

Theory of estimation: Characteristics of estimators, the concept of consistency, unbiasedness, and efficiency, Method of estimation, Cramer Rao Inequality

Module IV: Correlation and Regression

Bivariate normal distribution, types, importance, methods of measuring correlation-scatter diagram, Karl Pearson's, and Spearman's rank Correlation. Regression lines, Difference between regression and correlation, uses of Regression, Standard Error of estimate. Introduction of Partial and Multiple Correlations.

Text & References:

- Biswas and Srivastava- A Textbook, Mathematical Statistics, Ist Edition, Narosa Publishing House, New Delhi.
- Feller, W. (1971): Introduction to Probability Theory and its Applications, Vol. I and II. Wiley Eastern-Ltd
- V. K. Rohatgi, (1984): An Introduction to Probability Theory and Mathematical Statistics, Wiley Eastern.
- Hogg, R.V. and Craig, A.T. (1971): Introduction to Mathematical Statistics, McMillan.
- Mood, A.M., Graybill, F.A. and Boes, D.C. (1974): Introduction to the Theory of Statistics, McGraw Hill.
- Des Raj & Chandak (1998): Sampling Theory, Narosa Publishing House.
- Mathematical Statistics by Gupta and Kapoor, Sultan Chand, and Sons

Special Functions and Transform Calculus

COURSE CODE	CREDIT UNITS	CE Marks	ETE Marks	Total Marks
MAM 210	5	30	70	100

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Course Objective:

This course aims to provide basic ideas of the Laplace transform and how to compute it for standard examples, Applications of Fourier and Laplace transforms to partial differential equations, and the significance of absolute integrability.

Course Contents:

Module I: Gauss's Hypergeometric Functions: Definition, integral representation, deductions from integral representation, Gauss's hypergeometric differential equation and its solutions, relations between the solutions of a hypergeometric equation, relations of contiguity, two summation theorems, Kummer's confluent hypergeometric function.

Module II: Bessel's Functions and Legendre's Function: Bessel's functions of first and second kind, simple recurrence relations, orthogonal property of Bessel's, Transformation, Generating functions, Legendre's function of first kind. Simple recurrence relations, Orthogonal property, Generating functions.

Module III: Hermite Polynomials: Hermite differential equation and its solution, generating function, hypergeometric form, recurrence formulas, Rodrigue's formula, orthogonal property.

Module IV: Fourier Transform: Complex form of Fourier Transform and its inverse, Fourier sine and cosine transform and their inversion. Applications of Fourier Transform to the solution of partial differential equations having constant co-efficient with special reference to heat equation and wave equation.

Module V: Hankel Transform: Definition and elementary properties, inversion theorem, Hankel transform of derivatives, Parseval theorem.

Text and References:

Text:

- Special Functions, E.D. Rainville, Chelsea Publishing Comp.,
- Bronx, New York.
- The use of integral transforms, I.N. Sneddon, Mcgraw Hill
- Integral Transform, Sharma, and Vasishtha

Reference:

- Advanced Differential Equations, M.D. Raisinghania, S.Chand & Comp., New Delhi.
- Special Functions and Their Applications, N. N. Lebedev [PH]

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DOMAIN ELECTIVES

NUMERICAL METHODS AND DATA ANALYSIS

COURSE CODE	CREDIT UNITS	CE Marks	ETE Marks	Total Marks
MAM202	5	30	70	100

Course Objective:

The objective of the present course is to introduce some advanced measurement, numerical methods, and data analysis commonly used in research to postgraduate students.

Course Contents:

Module I: Solution of Algebraic and Transcendental Equations

Bisection method, Muller's method, Newton-Raphson method, Solution of simultaneous linear equations: Gauss' Elimination Method, Jacobi iterative method, Gauss-Seidel method.

Module II: Finite Difference, Interpolation, and Curve Fitting

Finite differences, Newton's formula for interpolation, Gauss, Stirling, Bessel's, Everett's formulae, Divided differences, Newton's general interpolation formula, Lagrange's interpolation formula, Method of Least square curve fitting, straight line and quadratic equation fitting, curve fitting by the sum of exponentials.

Module III: Numerical Differentiation, Integration and Ordinary Differential Equations

Numerical differentiation, Numerical integration, Trapezoidal rule, Simpson 1/3 and 3/8 rules, and Gauss quadrature formula. Numerical solution of ordinary differential equations using Euler, Picard, and Runge-Kutta methods of 2^{nd} and 4^{th} order.

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Module IV: Data Analysis

Data interpretation and analysis: Precision and accuracy, error analysis, propagation of errors, Gaussian distribution, determination of mean value and standard deviation of the continuous Gaussian distribution, graphical representation of functional relationship, linear and nonlinear least square curve fitting, chi-square test for goodness of fit.

Text & References:

- S.S. Shastri, Introductory Methods of Numerical Analysis, Pearson Education
- C.E. Froberg, Introduction to Numerical Analysis, Addison –Wesley 1981.
- E. Scheid, Numerical Analysis, Mc Graw Hill 1988.
- M.K. Jain, S.R.K. Iyengar and R. K. Jain, Numerical methods for scientific & Engineering. Computations, New Age International Publishers, New Delhi.

K Atkinson, Elementary Numerical Analysis, Wiley 1985.

TOPOLOGY

COURSE CODE	CREDIT UNITS	CE Marks	ETE Marks	Total Marks
MAM207	5	30	70	100

Course Objective:

Topology is a modern branch of geometry. It serves to lay the strong foundations of concepts for study in analysis and geometry. It is also a prerequisite for many concepts related to Analysis.

The course is designed to develop an understanding of topological ideas & techniques and their role in analysis.

Course Contents:

Module I: Definition and examples of topological space

Base and sub base for a topology, Subspaces, and relative topology, Closed sets, Neighbourhoods, interior, exterior, boundary, contact and limit points of sets, derived sets, dense sets, and nowhere dense subsets. Alternate methods of defining a topology in terms of Kuratowski Closure Operator and Neighborhood Systems,

Homeomorphism: Definition and properties of continuous function, open functions, closed functions, Homeomorphisms uniform continuous functions.

Product spaces: Box topology, weak topology, Tychonoff topology.

Module II: Countability and Separation Axioms

First and Second Countable spaces, Lindeloff spaces, Separable spaces. Their relationship among themselves and other basis properties, To, T1, T2, regular and T_3, completely regular and T3½, normal and T_4 separation axioms, their Characterizations, and basic properties. Urysohn's lemma, Tietze extension theorem.

Module III: Compactness

Continuous functions and compact sets. Basic properties of compactness. Compactness and finite intersection property, sequential and countable compact sets. Compactness in metric spaces. Equivalence of compactness, countable compactness, and sequential compactness in metric spaces. Tychonoff's Product Theorem. Local compactness, Compactification, one point, and Stone - Cech compactification.

Module IV: Connected Spaces

Separated sets, Connected, and disconnected sets, continuity and connectedness, components, totally disconnected spaces, Connectedness and the real line, and locally connected spaces.

Text & References:

Text:

- R. Munkres, Topology, A First Course, Pearson. N. Delhi, 2000.
- W. J. Pervin, Foundation of General Topology, Academic Press Inc., New York, 1964

Reference:

- N. Bourbaki, Topology I and II, Springer Verlag, New Delhi
- S. Willard, General Topology, Addison-Wesley, Reading, 1970. Reprinted by Dover
- J. Dugundji, Topology, Allyn and Bacon, 1966 (Reprinted in India by PHI).
- J. L. Kelley, General Topology, D Van Nostrand Reinhold Co. New York 1955 (Reprinted by Springer Verlag, New York.
- K D Joshi, Introduction to General Topology, New Age International (p) Ltd, 1983
- L. A. Steen and J ASeebach, Counter Examples in Topology, Holt, Reinhart and Winston, Inc. New York, 1970.

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THIRD SEMESTER

MATHEMATICAL MODELING

COURSE CODE	CREDIT UNITS	CE Marks	ETE Marks	Total Marks
MAM301	5	30	70	100

Course Objective:

Mathematical modeling is a process of creating a mathematical representation of some phenomenon to gain a better understanding of that phenomenon. The main goal of this course is to learn how to make creative use of some mathematical tools such as difference equations, ordinary and partial differential equations, and Numerical analysis to build a mathematical description of some physical problems.

Course Contents:

Module I

Introduction to modeling, Examples and definitions, classification of mathematical Modeling, Dimensional Analysis, Traffic flow modeling, techniques of mathematical modeling, Characteristics of mathematical modeling, steps in mathematical modeling, limitations of mathematical modeling.

Module II

Modeling and Simulation, Methods of developing a simulation model, designing a simulation experiment, how to perform simulation analysis, Advantages of simulation modeling, and some pitfalls to guard against simulation.

Module III

Modeling with difference equations, an overview of basic concepts concerning matrices, eigenvalues, and eigenvectors.

Module IV

Queuing models, Poisson Process, Pure birth-death process – M/M/1, M/M/c, M/Ek/1 queuing models, steady-state probabilities, waiting time distribution.

Module V

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Mathematical modeling through calculus of variations and dynamic programming, optimization principles and techniques, Problems related to maximum entropy distribution, geometrical problems, bio-economic problems, maximization and minimization problems, cargo loading problems, transportation problems, and inventory problems.

Text & References:

Text:

- J N Kapur, Mathematical Modeling, New Age International (P) Ltd., Publishers, New Delhi

References:

- 1. Hamdy A Taha, Operations Research, Pearson Educational Asia Edition
- F R Giordano, M D Weir, and WP Fox, A First Course in Mathematical Modeling
- A. Maria, Introduction to Modeling and Simulation, Proceedings, Winter Simulation Conference, 1997
- M M Gibbons, A Concrete Approach to Mathematical Modeling, John Wiley, and Sons.
- P.E. Wellstead, Introduction to Physical System Modeling, Academic Press, 1977.

DISCRETE MATHEMATICAL STRUCTURES

COURSE CODE	CREDIT UNITS	CE Marks	ETE Marks	Total Marks
MAM 303	5	30	70	100

Course Objective:

Discrete structure is the study of the logical and algebraic relationships between discrete objects. At the end of the course, students will be able to relate computing theory with applications, understand and design finite state machines, understand the importance of graph algorithms

Course Contents:

Module I

Lattices: Lattices as partially ordered sets, their properties, duality, Lattices as algebraic systems, Sub lattices, Direct products, Bounded Lattices, Complete Lattices, Complemented Lattices, and Distributive lattices. Cover of elements, atoms, join and meet irreducible elements.

Module II

Boolean Algebras: Boolean Algebras as lattices. Various Boolean Identities. The Switching Algebra example. Sub algebras, Direct products, and Homeomorphisms. Boolean forms and their Equivalence. Min-term Boolean forms, Sum of product Canonical forms. Minimization of Boolean functions, The Karnaugh Map method.

Module III

Definition of (undirected) graph, Walk, Path, Circuit, Cycles, Degree of a vertex, connected graphs, Complete and Bipartite graphs, Planar graphs, Euler's formula for connected Planar graphs, Kuratowski's Theorem (Statement only) and its uses. Coloring of graphs, five-color theorem, and statement of four-color theorem.

Module IV

Trees, Cut-sets, Spanning Trees, Fundamentals Cut-sets and Minimum Spanning Trees, Prim's and Kruskal's algorithms, Connectivity, Matrix Representation of graphs, Directed Graphs, Indegree and outdegree of a vertex.

Text & References:

- J. P. Trembley & R. Manohar, Discrete Mathematical Structures with Applications to Computer Science, McGraw-Hill Book Co., 1997.
- J. L. Gersting, Mathematical Structure for Computer Science (3^{rd}ed.), Computer Science Press,
- Seymour Lepschutz, Finite Mathematics, McGraw-Hill Book Co. New –York.
- J. E. Hopcroft and J.D. Ullman, Introduction to Automata Theory Languages & Computation,Narosa Publishing House, Delhi.
- C. L. Liu, Elements of Discrete Mathematics, Tata McGraw-Hill Publishing Co. Ltd, New Delhi.

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PARTIAL DIFFERENTIAL EQUATIONS

COURSE CODE	CREDIT UNITS	CE Marks	ETE Marks	Total Marks
MAM 308	5	30	70	100

Course Objective:

This course aims to acquaint the students with various mathematical techniques for the classification of PDE and their solutions. The students will be taught the Transport equation, Laplace's equation, Heat equations, Green's function, wave equations, and the approach to solving various boundary value problems involving parabolic, elliptic, and hyperbolic differential equations that arise in many physical situations.

Course Contents:

Module I

Partial Differential Equation (PDE) of first order, origin of first order PDE & their classification, classifications of integrals. The Cauchy problem integral surfaces passing through a given curve. Charpit‟s method, Jacobi‟s method.

Module II

Second-order PDE with constant coefficients, Linear second-order PDE with variable coefficients, classification of second-order PDE, reduction to canonical forms. Homogeneous PDE

Module III

Transport Equation, Quasilinear equation, Laplace‟s equation, Analytic solutions of Laplace Equation in 2D Cartesian and polar coordinates, Interior & Exterior Dirichlet‟s problem, Neumann problem, Heat equation, solution by method of characteristics, solution by separation of variables.

Module IV

D‟Alembert solution of one-dimensional homogeneous un-damped wave equation, initial value problems, solution of the wave equation for infinite string, semi-infinite string, finite string problems, Solution of one-dimensional damped wave equation, Solution by the method of separation of variable

Module V

Nonlinear first-order PDE, generalizations, Nonlinear waves and shocks, conservation laws and shocks, The Rankine Hugonit conditions, Nonlinear diffusion equation, Burger‟s equation, and The Hopf-Cole Transformation.

Text & References:

1. L.C. Evans, Partial Differential Equations, Graduate Studies in Mathematics, Volume 19, AMS, 1998

2. N. Sneddon, Partial Differential Equation, Tata McGraw Hill, New Delhi, 1983

3. T. Amarnath, An elementary course in Partial Differential Equations, second edition, Narosa Publishing House, New Delhi

4. G. Donald, Introduction to Partial Differential Equations, Tata Mc Graw Hill, New Delhi, 1961.

DOMAIN ELECTIVES

MATHEMATICAL METHODS

COURSE CODE	CREDIT UNITS	CE Marks	ETE Marks	Total Marks
MAM 304	5	30	70	100

Course Objective:

Mathematics abounds in various techniques for solving different types of problems in almost all disciplines. The present course covers three important techniques namely, variation technique, Transforms, and Integral equations methods for solving ordinary and partial differential equations involving initial and boundary value conditions.

Course Contents:

Module I

Functional and their Properties, Motivating problems of Calculus of Variation, Shortest Distance, Minimum Surface of Revolution, Branchistochrone problem, Isoperimetric problem, Geodesic problem Fundamental lemma of Calculus of Variation.

Module II

Euler's Equation for one dependent function and its generalization to n-dependent functions and higher order derivatives, Variational problem with moving boundaries, Variation under constraints Rayleigh-Ritz method.

Module III

Integral Equations and their Classification, Relation between Integral and differential Equation, Fredholm and Volterra equations, Separable kernels, Reduction to a system of algebraic equations, Eigen values, and Eigen functions.

Module IV

Iterated Kernels, Iterative Scheme for solving Fredholm Integral Equation of the second kind (Neumann Series), Resolvent Kernel, Volterra Equations, Kernels and Functions, Volterra equation of first and second kind, Volterra integral equation and Linear Differential equation. Laplace Transform and its applications in solving Linear Differential Equations

Text & References:

Text:

- F.B.Hilderbrand, Methods of Applied Mathematics, Prentice Hall of India, New Delhi.

References:

- V.Lovitt, Linear Integral Equation, Wiley Inter science New York.
- R.P. Kanwal, Linear Integral Equation Theory and Technique, Academic Press New York.
- L.Elsgols; Differential Equation and Calculus of Variation, Mir Publication, Moscow.

LEBESGUE MEASURE THEORY

COURSE CODE	CREDIT UNITS	CE Marks	ETE Marks	Total Marks
MAM 309	5	30	70	100

Course Objective:

The objective of the present course is to introduce some advanced measure theory concepts commonly used in research to the post graduate students.

Course Contents:

Module I:
Semi-algebra, Algebra, Monotone class, Sigma-algebra, Monotone class theorem. Measure spaces. Extension of measures from algebras to the generated sigma-algebras: Measurable sets; Lebesgue Measure and its properties.

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Module II:

Measurable functions and their properties; Integration and Convergence theorems. Introduction to Lp-spaces, Riesz-Fischer theorem; Riesz Representation theorem for L2 spaces. Absolute continuity of measures, Radon-Nikodym theorem. Dual ofLp-spaces.

Module III:

Product Measure. Product measure spaces, Fubini's theorem. Differentiation of integrals, continuous functions. Fundamental Theorem of Calculus for Lebesgue Integrals

Text & References:

1. Inder K. Rana, An Introduction to Measure and Integration (2nd ed.), Narosa Publishing House, New Delhi, 2004.
2. H.L. Royden, Real Analysis, 3rd ed., Macmillan, 1988**.**
3. G.De.Barra, Measure theory and integration.
4. P. Billingsley, Probability and Measure. John Wiley and Sons, Inc.,1995.

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FOURTH SEMESTER

PROJECT

COURSE CODE	CREDIT UNITS	CE Marks	ETE Marks	Total Marks
MAM 460	27	30	70	100

GUIDELINES FOR PROJECT FILE AND PROJECT REPORT

Research experience is as close to a professional problem-solving activity as anything in the curriculum. It provides exposure to research methodology and an opportunity to work closely with a faculty guide. It usually requires the use of advanced concepts, a variety of experimental techniques, and state-of-the-art instrumentation.

Research is a genuine exploration of the unknown that leads to new knowledge which often warrants publication. But whether the results of a research project are publishable, the project should be communicated in the form of a research report written by the student.

Sufficient time should be allowed for satisfactory completion of reports, considering that initial drafts should be critically analyzed by the faculty guide and corrected by the student at each stage.

PROJECT FILE

The Project File may be a very useful tool for undertaking an assignment along with a normal semester, an exploratory study, sponsored projects, a project undertaken during the summer period, or any other period as per curriculum where the researcher is working with a company/organization. The project/ assignment may also be a part of the bigger research agenda being pursued by a faculty/ institution/ department..

The Project File is the principal means by which the work carried out will be assessed and therefore great care should be taken in its preparation. This file may be considered in continuous assessment.

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In general, the File should be comprehensive and include:

- A short account of the activities that were undertaken as part of the project.
- A statement about the extent to which the project has achieved its stated objectives.
- A statement about the outcomes of the evaluation and dissemination processes engaged in as part of the project.
- Any activities planned but not yet completed as part of the project, or as a future initiative directly resulting from the project.
- Any problems that have arisen and may be useful to document for future reference.

PROJECT REPORT

The Project Report is the final research report that the student prepares on the project assigned to him. In the case of a sponsored project, the lay out of the project could be as prescribed by the sponsoring organization. However, in other cases, the following components should be included in the project report:

- **Title or Cover Page**
  The title page should contain the Project Title; Student's Name; Programme; Year and Semester and Name of the Faculty Guide.

- **Acknowledgement(s)**
  Acknowledgment to any advisory or financial assistance received in the course of work may be given. It is incomplete without the student's signature.

- **Abstract**
  A good "Abstract" should be straight to the point; not too descriptive but fully informative. The first paragraph should state what was accomplished about the objectives. The abstract does not have to be an entire summary of the project, but rather a concise summary of the scope and results of the project. It should not exceed more than 1000 words.

- **Table of Contents**
  Titles and subtitles are to correspond exactly with those in the text.

- **Introduction**
  Here a brief introduction to the problem that is central to the project and an outline of the structure of the rest of the report should be provided. The introduction should aim to catch the imagination of the reader, so excessive details should be avoided.

- **Materials and Methods**

  This section should aim at experimental designs, and materials used (wherever applicable). The methodology should be mentioned in detail including modifications undertaken, if any. It includes organization site(s), sample, instruments used with its validation, procedures followed, and precautions.

- **Results and Discussion**

  Present results, discuss and compare these with those from other workers, etc. In writing this section, emphasis should be laid on what has been performed and achieved in the course of the work, rather than discussing in detail what is readily available in textbooks. Avoid abrupt changes in contents from section to section and maintain a lucid flow throughout the thesis. An opening and closing paragraph in every chapter could be included to aid in smooth flow.

  Note that in writing the various sections, all figures and tables should as far as possible be next to the associated text, in the same orientation as the main text, numbered, and given appropriate titles or captions. All major equations should also be numbered and unless it is really necessary, do not write in "point" form.

  While presenting the results, write at length about the various statistical tools used in the data interpretation. The result interpretation should be simple but full of data and statistical analysis. This data interpretation should be in congruence with the written objectives and the inferences should be drawn on data and not on impression. Avoid writing straightforward conclusions rather, it should lead to the generalization of data on the chosen sample.

  Results and their discussion should support/contradict the previous research work in the given area. Usually one should not use more than two pieces of research in either case supporting or contradicting the present case of research.

- **Conclusion(s) & Recommendations**

  A conclusion should be the final section in which the outcome of the work is mentioned briefly.

  Check that your work answers the following questions:

  - Did the research project meet its aims (check back to introduction for stated aims)?
  - What are the main findings of the research?
  - Are there any recommendations?
  - Do you have any conclusion on the research process itself?

- **Implications for Future Research**

This should bring out further prospects for the study either thrown open by the present work or with the purpose of making it more comprehensive.

- **Appendices**

  The Appendices contain material which is of interest to the reader but not an integral part of the thesis and any problem that have arisen that may be useful to document for future reference.

- **References**

  References should include papers, books etc. referred to in the body of the report. These should be written in the alphabetical order of the author's surname. The titles of journals preferably should not be abbreviated; if they are, abbreviations must comply with an internationally recognised system.

  Examples:

  For research article:

  Voravuthikunchai SP, Lortheeranuwat A, Ninrprom T, Popaya W, Pongpaichit S, Supawita T. (2002) Antibacterial activity of Thai medicinal plants against enterohaemorrhagic *Escherichia coli* O157: H7. *Clin MicrobiolInfect* ,**8** (suppl 1): 116–117.

  For book:

  Kowalski,M.(1976) Transduction of effectiveness in *Rhizobium meliloti*. SYMBIOTIC NITROGEN FIXATION PLANTS (editor P.S. Nutman IBP), **7**: 63-67

The Layout Guidelines for the Project File & Project Report:

- A4 size Paper
- Font: Arial (10 points) or Times New Roman (12 points)
- Line spacing: 1.5
- Top and bottom margins: 1 inch/ 2.5 cm; left and right margins: 1.25 inches/ 3 cm

ASSESSMENT OF THE PROJECT FILE AND THE PROJECT REPORT

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Essentially, the assessment will be based on the quality of the report, the technical merit of the project, and the project execution. Technical merit attempts to assess the quality and depth of the intellectual efforts put into the project. Project execution is concerned with assessing how much work has been put in.

The Project should fulfill the following ***assessment objectives:***

- Range of Research Methods used to obtain information.
- Execution of Research
- Data Analysis (Analyze Quantitative/ Qualitative information)
- Quality Control
- Conclusions

Assessment Scheme:

Continuous Evaluation: 40% (Based on punctuality, regularity of work, adherence to plan and methodology, refinements/ mid-course corrections, etc. as reflected in the Project File.)

Final Evaluation: 60% (Based on the Documentation in the file, Final report layout, analysis and results, achievement of objectives, presentation/ viva)

It is recommended that the Final evaluation should be carried out by a panel of evaluators.