K.R. MANGALAM UNIVERSITY

THE COMPLETE WORLD OF EDUCATION

SCHOOL OF BASIC AND APPLIED SCIENCES

Master of Science Mathematics

M.Sc. Mathematics

Programme Code: 60

2021-2023

Approved in the 26th Meeting of Academic Council Held on 11

August 2021

Registrar
K.R. Mangalam University
Sohna Road, Gurugram, (Haryana)

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PREAMBLE

The objective of any programme at Higher Education Institute is to prepare their students for the society at large. The K. R. Mangalam University visualizes all its programmes in the best interest of their students and in this endeavour; it offers a new vision to all its Postgraduate courses. The credit system to be implemented through this curriculum, would allow students to develop a strong footing in the fundamentals and specialize in the disciplines of his/her liking and abilities. The students pursuing this course would have to develop in depth understanding of various aspects of the subject. The conceptual understanding, development of experimental skills, designing and implementation of novel synthetic methods, developing the aptitude for academic and professional skills, research skills, acquiring basic concepts for structural elucidation with hyphenated techniques, understanding the fundamental biological processes and rationale towards computer assisted drug designing are among such important aspects.

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Approved by:
Prof. C.S. Dubey
Vice-Chancellor
K.R.Mangalam University

1. Introduction

K.R. Mangalam University located on Sohna Road, Gurugram, is one of the fastest growing and most promising upcoming universities in India. It is a State Private University established in 2013 by an act of the legislature of the Haryana Government under Haryana Private Universities Act (Amendment) 8 of 2013.It is recognized by the UGC under Section 2f of the UGC Act, 1956. The primary aim of the University is to promote excellence in basic and professional education while upholding moral values.

KRMU offers sixty-eight Undergraduate, Postgraduate and Doctoral Degree programs across different disciplines. The group of educational units in the University promote education in the areas of Engineering & Technology, Legal Studies, Basic and Applied Sciences, Management Sciences, Commerce, Journalism and Mass Communication, Hotel Management and Catering Technology, Medical and Allied Sciences, Architecture and Planning, Agriculture, Fashion Designing, Humanities and Education. All the disciplines follow a well-defined curriculum design keeping in view the guidelines of UGC/AICTE and appropriate regulatory bodies like Council of Architecture (COA), Bar Council of India (BCI), Pharmacy Council of India (PCI), National Council for Teachers Education (NCTE) etc., wherever applicable. All courses are semester and credit based.

K. R. Mangalam University is unique because of its

- An enduring legacy of providing education to high achievers who demonstrate leadership in diverse fields.
- Protective and nurturing environment for teaching, research, creativity, scholarship, social and economic justice.

Objectives

i. To impart undergraduate, post-graduate and Doctoral education in identified areas of higher education.
ii. To undertake research programmes with industrial interface.
iii. To integrate its growth with the global needs and expectations of the major stake holders through teaching, research, exchange & collaborative programmes with foreign, Indian Universities/Institutions and MNCs.
iv. To act as a nodal center for transfer of technology to the industry
v. To provide job oriented professional education to the pecia student community with particular focus on Haryana.

2. About the School

The school imparts both teaching and research through its various science disciplines viz Mathematics, Chemistry and Physics.

School of Basic and Applied Sciences imparts students disciplinary knowledge, enhances their skills and ability, motivating them to think ingeniously, helping them to act independently and take decisions accordingly in all their scientific pursuits and other endeavours. It strives to empower its students and faculty members to contribute for the development of society and Nation.

The faculty is in constant touch with various experts in the relevant fields and is willing to experiment with latest ideas in teaching and research.

VISION

- School of Basic and Applied Sciences intends for continuum growth as centre of advanced learning, research and innovation by disseminating analytical and scientific knowledge in the areas of basic and applied sciences by promoting interdisciplinary research and scientific acumen.

MISSION

- **M1**: Enable students to be scientists/ academicians /entrepreneurs by accomplishing fundamental and advanced research in diverse areas of basic and applied sciences.

- **M2**: Build strong associations with academic organizations/industries for knowledge creation, advancement, and application of scientific fervor.

- **M3**: Create conducive environment for lifelong learning.

- **M4**: Empower students to be socially responsible and ethically strong individuals through value-based science education.

The school comprises undergraduate, postgraduate and Doctor of Chemistry, Physics and Mathematics.

3. Programmes offered by the School

School offers undergraduate B.Sc. (Hons) Programmes, postgraduate M.Sc. Programmes, and Doctoral Programmes. All these programmes are designed to impart scientific knowledge to the students and are aimed to provide theoretical as well as practical training in their respective fields.
School offers postgraduate M.Sc. Mathematics. This school established in 2013. This course emphasized on hands on practice, innovative thought process and project-based learning.

Graduate Attributes

GA1: To demonstrate competence in discipline specific theoretical and practical knowledge
GA2: To develop creativity and innovation
GA3: To enhance communication and interpersonal skills
GA4: To enable critical & logical thinking and investigative research attitude amongst students
GA5: To develop ethical values, teamwork and lifelong learning approach

Programme Educational Objectives (PEOs)
PEO1: Apply their knowledge in modern industry or teaching, or secure acceptance in high-quality graduate programs in mathematics.

PEO2: Development in their chosen profession and/or progress toward an advanced degree

PEO3: The trust and respect of others as effective and ethical team members.

PEO4: Graduates will become effective collaborators and innovators, leading or participating in efforts to address social, technical and business challenges.

PEO5: Promote the culture of interdisciplinary research among all disciplines and applied mathematics.

Programme Outcomes (POs)

PO1	Encourage critical thinking to conduct scientific investigations in a biased manner without prejudiced assumptions.
PO2	Assist students in analyzing questions, formulating hypotheses, evaluating and validating findings, and drawing logical conclusions.
PO3	Prepare students for pursuing research or careers and to design methods to conduct investigations of complex societal and environmental issues.
PO4	Continue to acquire relevant knowledge and skills to evaluate the concepts and scientific developments to take up any challenge.
PO5	Enhance knowledge mobilization through increased application of mathematics.
PO6	Able to use the advance knowledge in consultancy to solve real life problems.
PO7	Learn the subject with curiosity to understand new scientific developments.

PO8. Understand international perspective about mathematics.
PO9 Capability to use appropriate software's to solve mathematical equations.
PO10 Develop the protocols as per laboratory standards to accomplish the objectives.

Programme Specific Outcome (PSOs)

PSO1 Develop aptitude to formulate concepts based on fundamental axioms of Mathematics.
PSO2 Innovate, invent and solve complex mathematical problems using the knowledge of pure and applied Mathematics.
PSO3 Understand demands of the growing field of Mathematics by lifelong learning.
PSO4 Develop problem-solving skills, critical thinking, and interest through assignments and project work.
PSO5 Prepare students for competitive examinations such as NET, GATE, and many others.

4. M.Sc. Mathematics

The M.Sc. in Mathematics provides a broad and flexible training in variety of courses tailored to your own interests and needs, ranging from pure mathematics to mathematical modelling, computational mathematics, and applications of mathematics to many research areas.

The programme offers a substantial opportunity for independent study and research in the form of a dissertation. The dissertation is undertaken under the guidance of a supervisor and will typically involve investigating and writing in a particular area of mathematical sciences. A dissertation gives students the opportunity to develop broader transferable skills in the processes of organizing, communicating, and presenting their work, and will equip students well for further research or for a wide variety of other careers.

Eligibility Criteria: - He/ She should have passed the B.Sc. (Hons) Mathematics / B.Sc. with Mathematics as a major subject, from a recognized University or equivalent with a minimum of 50% marks in aggregate.

Course Outline: - Real Analysis/ Complex Analysis/ Functional Analysis/ Topology/ Advanced Algebra/ Measure and Integration/ Industrial & Applied Mathematics/ Numerical Analysis & Scientific Computing.

Career Options: - Opportunities exist in researchers, teachers, or even work in many branches of Engineering, Finance, Physics, Chemistry, Medicine and more.

5 Programme Duration

The minimum period required for the M.Sc. Programme offered by the University shall extend over a period of two Academic Years.
The maximum period for the completion of the M.Sc. Programme offered by the University shall be four years.

6. Class Timings

The classes will be held from Monday to Friday from 09:10 am to 04:10 pm.

7. Scheme of Studies and Syllabi

The syllabi of M.Sc. Mathematics offered by School of Basic and Applied Sciences with scheme of studies are given in the following pages.

M.Sc. Mathematics Programme at a Glance

SEMESTER	I	II	III	IV	TOTAL
COURSES	7	7	5	5	24
CREDITS	20	22	22	22	86

Scheme of Studies as per Choice-Based Credit System and Learning Outcome-Based Curriculum Framework

SEMESTER – I							
SN	**COURSE CODE**	**NATURE OF COURSE**	**COURSE TITLE**	**L**	**T**	**P**	**C**
1	BSMA701A	CC	Linear Algebra	4	0	0	4
2	BSMA703A	CC	Real Analysis	4	0	0	4
3	BSMA707A	CC	Integral Equations and Calculus of Variations	4	0	0	4
4	BSMA711A	CC	Advanced MATLAB Programming	2	0	0	2
5	BSMA713A	CC	Probability and Statistics	4	0	0	4
6	BSMA771A	CC	Advanced MATLAB Programming Lab	0	0	2	1
7	BSMA773A	CC	Probability and Statistics Lab	0	0	2	1
TOTAL				**18**	**0**	**4**	**20**

SEMESTER – II							
SN	**COURSE CODE**	**NATURE OF COURSE**	**COURSE TITLE**	**L**	**T**	**P**	**C**
1	BSMA702A	CC	Abstract Algebra-I	4	0	0	4
2	BSMA704A	CC	Topology	4	0	0	4
3	BSMA706A	CC	Complex Analysis	4	0	0	4
4	BSMA708A	CC	Advanced Ordinary Differential Equations	4	0	0	4
5	BSMA712A	CC	Numerical Analysis	4	0	0	4
6	BSMA772A	CC	Numerical Analysis Lab	0	0	2	1
7	BSMA776A	SEC	LaTeX Lab	0	0	2	1
TOTAL				**20**	**0**	**4**	**22**

SEMESTER – III							
SN	**COURSE CODE**	**NATURE OF COURSE**	**COURSE TITLE**	**L**	**T**	**P**	**C**
1	BSMA801A	CC	Abstract Algebra-II	4	0	0	4
2	BSMA803A	CC	Measure and Integration	4	0	0	4
3	BSMA805A	CC	Advanced Partial Differential Equations	4	0	0	4
4		DSE	Discipline Elective - I	4	0	2	5
5		DSE	Discipline Elective - II	4	0	2	5
TOTAL				**20**	**0**	**4**	**22**

SEMESTER – IV							
SN	**COURSE CODE**	**NATURE OF COURSE**	**COURSE TITLE**	**L**	**T**	**P**	**C**
1	BSMA802A	CC	Functional Analysis	4	0	0	4
2	BSMA804A	CC	Mathematical Programming	4	0	0	4
3		DSE	Discipline Elective - III	4	0	0	4
4		DSE	Discipline Elective - IV	4	0	0	4
5	BSMA852A	SEC	Dissertation	0	0	0	6
TOTAL				**16**	**0**	**0**	**22**

Total Credits [C]	**86**

Discipline Electives

Discipline Elective I - II (Choose any two)						
SN	**COURSE CODE**	**COURSE TITLE**	**L**	**T**	**P**	**C**
1	BSMA821A	Mathematical Modelling	4	0	0	4
	BSMA871A	Mathematical Modelling Lab	0	0	2	1
2	BSMA823A	Operational Research	4	0	0	4
	BSMA873A	Operational Research Lab	0	0	2	1
3	BSMA825A	Basics of Statistical Inference	4	0	0	4
	BSMA875A	Basics of Statistical Inference Lab	0	0	2	1
4	BSMA827A	Stochastic Processes and Queuing Theory	4	0	0	4
	BSMA877A	Stochastic Processes and Queuing Theory Lab	0	0	2	1
5	BSCA 330A	Network Security & Cryptography	4	0	0	4
	BSCA 372A	Network Security & Cryptography Lab	0	0	2	1
6	BSCS401A	Artificial Intelligence	4	0	0	4
	BSCS 451A	Artificial Intelligence Lab	0	0	2	1

Discipline Elective III - IV (Choose any two courses from one group)						
Group A						
SN	**COURSE CODE**	**COURSE TITLE**	**L**	**T**	**P**	**C**
1	BSMA828A	Number Theory	4	0	0	4
2	BSMA830A	Advanced Measure Theory	4	0	0	4
3	BSMA832A	Theory of Bounded Operators	4	0	0	4
4	BSMA834A	Harmonic Analysis	4	0	0	4
Group B						
SN	**COURSE CODE**	**COURSE TITLE**	**L**	**T**	**P**	**C**
1	BSMA806A	Fuzzy Sets and Applications	4	0	0	4
2	BSMA809A	Fluid Dynamics	4	0	0	4
3	BSMA812A	Mathematical Biology	4	0	0	4
4	BSMA818A	Discrete Mathematics	4	0	0	4

Course Type	Nomenclature
CC	Core Course
SEC	Skill Enhancement Course
AECC	Ability Enhancement Compulsory Course
GEC	Generic Elective Course
DSE	Discipline Specific Course

Course Objectives

1. To assimilate the brief idea to students of vector spaces, basis.
2. Provide a brief knowledge linear transformation and matrix representation of a linear transformation.
3. Find the Eigen values and eigen vectors of LT. Diagonalization, Cayley Hamilton Theorem.
4. Determined the inner product spaces and Orthonormal basis.
5. Apply the diagonalization of the matrix and Cayley Hamilton methods for appearing in social sciences, physical sciences, life sciences and a host of other disciplines.

Course Outcomes

On completion of this course, the students will be able to

CO1. Applied the methods vector and matrix algebra, including linear dependence / independence, basis and dimension of a subspace, rank and nullity, for analysis of matrices and systems of linear equations.

CO2. Appreciate how functions can be used linear transformations of finite dimensional vector spaces and compose their matrices in specific bases.

CO3. Recognize the characteristic polynomial to compute the eigenvalues and eigenvectors of a square matrix and use them to diagonalise matrices when this is possible; discriminate between diagonalizable and non-diagonalizable matrices.

CO4. Learn the concepts of Orthogonally diagonalize symmetric matrices and quadratic forms and apply the concepts to solve problems.

CO5. Determine the concept of the diagonalization and higher power of the matrix by using Gauss Jorden method.

CO6. Apply the methods of matrix algebra to compose the change-of-basis matrix with respect to two bases of a vector space.

Catalog Description

This is a one semester introductory course in linear algebra. This course includes, but is not limited to, the study of systems of linear equations, matrices, determinants, vectors and vector spaces, linear transformations, eigenvalues and eigenvectors, and their applications. Important objectives of the linear algebra are to develop and strengthen the students' problem-solving skills and to teach them to read, write, speak, and think in the language of mathematics. In particular, students learn how to apply the tools of calculus to a variety of problem situations.

Course Content

Unit I: **16 lecture hours**

Vector Space and Subspace: Vector spaces, subspaces, algebra of subspaces, quotient spaces, linear combination of vectors, linear span, linear dependence and independence, basis and dimension, dimension of subspaces.

Unit II: **16 lecture hours**

Linear transformations: Linear transformations, null space, range, rank and nullity of a linear transformation, matrix representation of a linear transformation, algebra of linear transformations.

Unit III: **16 lecture hours**

Basis and Eigen Spaces: Change of basis. Dual spaces, bi dual space and natural isomorphism, Adjoint of Linear Transformation, Bilinear, Quadratic and Hermitian forms. Eigen values and eigen vectors of LT. Diagonalization, Cayley Hamilton theorem, Annihilator of a subspace

Unit IV: **12 lecture hours**

Inner product spaces: Inner product spaces, Cauchy-Schwarz inequality, orthogonal vectors, Orthonormal basis, Bessel's inequality, Gram-Schmidt Orthogonalization process

Textbooks

1. A. R. Vasishtha, J.N. Sharma, A. K. Vasishtha; Linear Algebra; Krishna Prakashan, Meerut.
2. Kenneth Hoffman, Ray Alden Kunz; Linear Algebra; Prentice-Hall of India Pvt.

Reference Books/Materials

1. Joseph A. Gallian; Contemporary Abstract Algebra; Narosa Publishing House.
2. S. Lang; Introduction to Linear Algebra; Springer.
3. S. Kumaresan; Linear Algebra- A Geometric Approach; Prentice Hall of India.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	10	10	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Applied the methods vector and matrix algebra, including linear dependence / independence, basis and dimension of a subspace, rank and nullity, for analysis of matrices and systems of linear equations.	**PO1**
CO2	Appreciate how functions can be used linear transformations of finite dimensional vector spaces and compose their matrices in specific bases.	**PO8**
CO3	Recognize the characteristic polynomial to compute the eigenvalues and eigenvectors of a square matrix and use them to diagonalise matrices when this is possible; discriminate between diagonalizable and non-diagonalizable matrices.	**PO2**
CO4	Learn the concepts of Orthogonally diagonalize symmetric matrices and quadratic forms and apply the concepts to solve problems.	**PO4**
CO5	Determine the concept of the diagonalization and higher power of the matrix by using Gauss Jorden method.	**PO3**
CO6	Apply the methods of matrix algebra to compose the change-of-basis matrix with respect to two bases of a vector space.	**PO1**

		Encourage critical thinking to conduct scientific investigations in a biased manner without prejudiced assumptions.	Assist students in analyzing questions, formulating hypotheses, evaluating and validating findings, and drawing logical conclusions.	Prepare students for pursuing research or careers and to design methods to conduct investigations of complex societal and environmental issues.	Continue to acquire relevant knowledge and skills to evaluate the concepts and scientific developments to take up any challenge.	Enhance knowledge mobilization through increased application of mathematics.	Able to use the advance knowledge in consultancy to solve real life problems.	Learn the subject with curiosity to understand new scientific developments.	Understand international perspective about mathematics.	Capability to use appropriate software's to solve mathematical equations.	Develop the protocols as per laboratory standards to accomplish the objectives.	Develop aptitude to formulate concepts based on fundamental axioms of mathematics.	Innovate, invent and solve complex mathematical problems using the knowledge of pure and applied mathematics.	Understand demands of the growing field of Mathematics by lifelong learning.	Develop problem-solving skills, critical thinking, and interest through assignments and project work.	Prepare students for competitive examinations such as NET, GATE, and many others.
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
BSMA701A	Linear Algebra	2	3	3	2				2			3		3		3

1=weakly mapped
2= moderately mapped
3=strongly mapped

Programme and Course Mapping																
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	**2**											**3**	**2**	**1**	**1**	**2**	**2**
CO2								**2**				**3**	**2**	**1**	**1**	**2**	**2**
CO3		**3**										**3**	**2**	**1**	**1**	**2**	**2**
CO4				**2**								**3**	**2**	**1**	**1**	**2**	**2**
CO5			**3**									**3**	**2**	**1**	**1**	**2**	**2**
CO6	**3**											**3**	**2**	**1**	**1**	**2**	**2**
1=lightly mapped 2= moderately mapped 3=strongly mapped																	

Course Objectives

After successful completion of this course students will be able to

1. Learn basic properties and theorems of Real Numbers
2. Differentiate between Riemann Integral and lesbuage integral
3. Know about higher order derivative and their application
4. Explain Chain rule and Taylor's theorem for multivariate function
5. Analyse inverse and implicit function theorem

Course Outcomes

On completion of this course, the students will be able to

CO1. Remember and understand important concepts of Riemann integration, upper sum, lower sum, higher order derivative, Jacobian.
CO2. Apply these concepts on other interrelated topics
CO3. Analyze and correlate difference between theorem, lemma and corollary.
CO4. Formulate and solve problems based upon higher order derivative.
CO5. Formulate and solve problems based upon partial differentiation and extremum value.

Catalogue Description

This course imparts the basic concepts of Riemann integration and Directional derivatives. It enables students to differentiate between inverse and implicit function theorem. This course helps students in variety of ways to solve the problems based upon extremum value,jacobians, partial differentiation efficiently. The course introduces the basic concepts about mean value theorem and Taylor's theorem. It also explain concept of Directional derivative.

Course Content

Unit I: **14 lecture hours**

Basics of Metric Spaces

Review of basic concepts of real numbers: Archimedean property, Completeness.
Metric spaces, compactness, connectedness, (with emphasis on R^n).

Unit II: **16 lecture hours**

Riemann Integral

Definition and existence of Riemann Stieltjes integral, properties of the integral, integration and differentiation, the fundamental theorem of integral calculus, integration by parts, integration of vector-valued functions, Rectifiable curves.

Unit III: **16 lecture hours**

Function of Several Variables

Functions of several variables: linear transformations, Derivative in an open subset of Rn, Chain rule, Partial derivatives, directional derivatives, the contraction principle, Banach fixed point theorem. Taylor's theorem for a function of several variables, Directional derivative.

Unit IV: **14 lecture hours**

Higher Order Derivatives

Inverse function theorem, Implicit function theorem, Jacobians, extremum problems with constraints, Lagrange's multiplier method, Derivatives of higher order, mean value theorem for real functions of two variables, interchange of the order of differentiation, Differentiation of integrals.

Textbooks

1. Walter Rudin; *Principles of Mathematical Analysis*, McGraw-Hill
2. T. Apostol; *Mathematical Analysis*, Narosa Publishers.
3. K. Ross; *Elementary Analysis: The Theory of Calculus*, Springer Int. Edition.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	10	10	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Remember and understand important concepts of Riemann integration and Directional derivatives	**PO1,PO7**
CO2	Apply these concepts to extremum value, jacobians, partial differentiation	**PO5,PO7**
CO3	Analyze and correlate difference between inverse and implicit function theorem	**PO8,PO7**
CO4	Formulate and solve problems based upon Directional derivative.	**PO4,PO7**
CO5	Formulate and solve problems based upon Taylor's theorem	**PO10,PO7**

		Encourage critical thinking to conduct scientific investigations in a biased manner without prejudiced assumptions.	Assist students in analyzing questions, formulating hypotheses, evaluating and validating findings, and drawing logical conclusions.	Prepare students for pursuing research or careers and to design methods to conduct investigations of complex societal and environmental issues.	Continue to acquire relevant knowledge and skills to evaluate the concepts and scientific developments to take up any challenge.	Enhance knowledge mobilization through increased application of mathematics.	Able to use the advance knowledge in consultancy to solve real life problems.	Learn the subject with curiosity to understand new scientific developments.	Understand international perspective about mathematics.	Capability to use appropriate software's to solve mathematical equations.	Develop the protocols as per laboratory standards to accomplish the objectives.	Develop aptitude to formulate concepts based on fundamental axioms of mathematics.	Innovate, invent and solve complex mathematical problems using the knowledge of pure and applied mathematics.	Understand demands of the growing field of Mathematics by lifelong learning.	Develop problem-solving skills, critical thinking, and interest through assignments and project work	Prepare students for competitive examinations such as NET, GATE, and many others.
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
BSMA 703A	Real Analysis	1			2	2		3	2		1	3	3	1	3	3

1=weakly mapped 2= moderately mapped 3=strongly mapped

Programme and Course Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PSO 1	PSO 2	PSO3	PSO4	PSO5	PSO6
CO1	**2**											**3**	**2**	**1**	**1**	**2**	**2**
CO2								**2**				**3**	**2**	**1**	**1**	**2**	**2**
CO3										**3**		**3**	**2**	**1**	**1**	**2**	**2**
CO4				**2**								**3**	**2**	**1**	**1**	**2**	**2**
CO5						**3**						**3**	**2**	**1**	**1**	**2**	**2**
CO6	**3**											**3**	**2**	**1**	**1**	**2**	**2**

1=lightly mapped 2= moderately mapped 3=strongly mapped

BSMA707A	INTEGRAL EQUATIONS AND CALCULUS OF VARIATIONS	L	T	P	C
Version 1.0		4	0	0	4
Total Contact Hours	60				
Pre-requisites/Exposure	Ordinary Differential Equations				
Co-requisites	--				

Course Objectives:

The course will enable the students to:

1. Understand more advanced concepts of linear integral equations
2. Solve problems of calculus of variations

Course Outcomes:

On completion of this course, the students will be able to

CO1. solve Volterra integral equations of second kind using iterated kernels
CO2. Apply successive approximation to solve Fredholm integral equation
CO3. construct the Green's function using various techniques
CO4. Use Euler's equation to solve problems in calculus of variations

Catalogue Description:

This course aims to deal with the solution of linear integral equations using some important techniques like Laplace transform and iterated kernels. The course begins with a review of some basic identities and integral equations with definitions and examples. Resolvent kernel, separable kernels and the Green's function are the key concepts in this learning programme. Moreover, some fundamental results and methods from calculus of variations are also considered in the plan of action.

Course Content

Unit I: **16 lecture hours**

Integral Equations

Linear integral equations, Some basic identities, Initial value problems reduced to Volterra integral equations, Methods of successive substitution and successive approximation to solve Volterra integral equations of second kind, Iterated kernels and Neumann series for Volterra equations. Resolvent kernel as a series, Laplace transform method for a difference kernel, Solution of a Volterra integral equation of the first kind.

Unit II: **16 lecture hours**

Boundary Value Problems

Boundary value problems reduced to Fredholm integral equations, Methods of successive approximation and successive substitution to solve Fredholm integral equations of second kind, Iterated kernels and Neumann series for Fredholm integral equations. Resolvent kernel as a sum of series, Fredholm resolvent kernel as a ratio of two series, Fredholm equations with separable kernels, Approximation of a kernel by a separable kernel, Non homogenous Fredholm equations with degenerate kernels.

Unit III: **14 lecture hours**

Green's Function

Green's function, Use of method of variation of parameters to construct the Green's function for a non-homogeneous linear second order boundary value problem, Basic four properties of the Green's function, Orthogonal series representation of Green's function, Alternate procedure for construction of the Green's function by using its basic four properties. Reduction of a boundary value problem to a Fredholm integral equation with kernel as Green's function, Hilbert-Schmidt theory for symmetric kernels.

Unit IV: **14 lecture hours**

Isoperimetric Problem

Motivating problems of calculus of variations, Shortest distance, Minimum surface of revolution, Brnchistochrone problem, Isoperimetric problem, Geodesic. Fundamental lemma of calculus of variations, Euler's equation for one dependant function and its generalization to 'n' dependant functions and to higher order derivatives, Conditional extremum under geometric constraints and under integral constraints.

Textbooks

1. J. Jerri; Introduction to Integral Equations with Applications, Wiley-Interscience Pub.
2. Abdul-Majid wazwaz; A first course in Integral Equations,World Scientific Pub.
3. J. M. Gelfand and S.V. Fomin; Calculus of Variations, Prentice Hall, New Jersy.

Reference Books/Materials

4. P. David and S. G. David Stirling; Integral Equations, Cambridge University Press.
5. Weinstock; Calculus of Variations, McGraw Hill

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination/ Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Solve Volterra integral equations of second kind using iterated kernels	**PO1**
CO2	Apply successive approximation to solve Fredholm integral equation	**PO4**
CO3	Construct the Green's function using various techniques	**PO9**
CO4	Use Euler's equation to solve problems in calculus of variations	**PO11**

		Encourage critical thinking to conduct scientific investigations in a biased manner without prejudiced assumptions.	Assist students in analyzing questions, formulating hypotheses, evaluating and validating findings, and drawing logical conclusions.	Prepare students for pursuing research or careers and to design methods to conduct investigations of complex societal and environmental issues.	Continue to acquire relevant knowledge and skills to evaluate the concepts and scientific developments to take up any challenge.	Enhance knowledge mobilization through increased application of mathematics.	Able to use the advance knowledge in consultancy to solve real life problems.	Learn the subject with curiosity to understand new scientific developments.	Understand international perspective about mathematics.	Capability to use appropriate software's to solve mathematical equations.	Develop the protocols as per laboratory standards to accomplish the objectives.	Develop aptitude to formulate concepts based on fundamental axioms of mathematics.	Innovate, invent and solve complex mathematical problems using the knowledge of pure and applied mathematics.	Understand demands of the growing field of Mathematics by lifelong learning.	Develop problem-solving skills, critical thinking, and interest through assignments and project work	Prepare students for competitive examinations such as NET, GATE, and many others.
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
BSMA 707A	Integral Equations and Calculus of Variations		3	3				3		2		3			2	

1=weakly mapped 2= moderately mapped 3=strongly mapped

Programme and Course Mapping																	
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	**2**											**3**	**2**	**1**	**1**	**2**	**2**
CO2								**2**				**3**	**2**	**1**	**1**	**2**	**2**
CO3		**3**										**3**	**2**	**1**	**1**	**2**	**2**
CO4				**2**								**3**	**2**	**1**	**1**	**2**	**2**
CO5			**3**									**3**	**2**	**1**	**1**	**2**	**2**
CO6	**3**											**3**	**2**	**1**	**1**	**2**	**2**
1=lightly mapped 2= moderately mapped 3=strongly mapped																	

BSMA711A	ADVANCED MATLAB PROGRAMMING	L	T	P	C
Version 2.0		2	0	0	2
Total Contact Hours	30				
Pre-requisites/Exposure					
Co-requisites	--				

Course Objectives

1. Understanding the large-scale data by conduct experiments, as well as to analyse and interpret data.
2. Introduced and identify, formulate, and solve engineering problems, function on multidisciplinary teams
3. Understanding of professional and ethical responsibility.
4. Recognition of the need for, and an ability to engage in life-long learning.
5. Understand the design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

Course Outcomes

On completion of this course, the students will be able to

1. Applied the knowledge and understanding to design and conduct experiments, as well as to analyse and interpret data.
2. Applied the concept of different type of function in multidisciplinary area.
3. Able to identify, formulate, and solve engineering problems.
4. Recognize and determined of professional and ethical responsibility.
5. Recognition of the need for, and an ability to engage in life-long learning.
6. An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

Catalog Description

The course is aimed for participants working or conducting research in scientific computing. Covered topics in scientific computing will include numerical linear algebra, numerical optimization, ODEs, and PDEs. Participants will be introduced to advanced MATLAB features, syntaxes, and toolboxes not traditionally found in introductory courses. Material will be reinforced with in-lecture examples, demos, and homework assignment involving topics from

scientific computing. MATLAB topics will be drawn from: advanced graphics (2D/3D plotting, graphics handles, publication quality graphics, animation), MATLAB tools (debugger, profiler), code optimization (vectorization, memory management), object-oriented programming, compiled MATLAB (MEX files and MATLAB coder), interfacing with external programs, toolboxes (optimization, parallel computing, symbolic math, PDEs). In exact, students learn how to apply the tools of calculus to a variety of problem situations.

Course Content

Unit I: **06 lecture hours**

Introduction to MATLAB: Starting and ending MATLAB session, MATLAB environment, MATLAB help, types of files, search path, some useful MATLAB commands, data types, constant and variables, Arithmetic, Relational and Logical Operators, built-in functions, Import and export of data, Working with files and directories.

Unit II: **08 lecture hours**

MATLAB Programming and Graphics: Function files, sub functions, global variations, loops, branches and control flow. Two-dimensional plots, multiple plots, style options, legend command, subplots , three-dimensional plots, Mesh and surface plots..

Unit III: **08 lecture hours**

Advanced Functions: Differentiation, Integration, Double integration, First and second order ODE, Publishing a report.

Unit IV: **08 lecture hours**

Symbolic Processing With MATLAB: Symbolic Expressions and Algebra, Algebraic and Transcendental Equations, Calculus, Symbolic Linear Algebra, ordinary and partial differential equation, Symbolic Tutors.

Reference Books/Materials

1. L.F. Shampine, I Gladwell, S. Thompson; Solving ODE's with MATLAB, Cambridge University Press.
2. Rudra Pratap; Getting Started with MATLAB 7, Oxford Press.
3. S.R. Otto and J.P. Denier, An Introduction to Programming and Numerical Methods in MATLAB, Springer.
4. Won Young Yang, Tae-Sang-Chung, John Morris; Applied numerical Methods using MATLAB, John Wiley and Sons.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	10	10	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	Mapped Program Outcomes
CO1	Applied the knowledge and understanding to design and conduct experiments, as well as to analyse and interpret data.	PO1
CO2	Applied the concept of different type of function in multidisciplinary area.	PO8
CO3	Able to identify, formulate, and solve engineering problems.	PO2
CO4	Recognize and determined of professional and ethical responsibility.	PO4
CO5	Recognition of the need for, and an ability to engage in life-long learning.	PO3
CO6	An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.	PO1

		Encourage critical thinking to conduct scientific investigations in a biased manner without prejudiced assumptions.	Assist students in analyzing questions, formulating hypotheses, evaluating and validating findings, and drawing logical conclusions.	Prepare students for pursuing research or careers and to design methods to conduct investigations of complex societal and environmental issues.	Continue to acquire relevant knowledge and skills to evaluate the concepts and scientific developments to take up any challenge.	Enhance knowledge mobilization through increased application of mathematics.	Able to use the advance knowledge in consultancy to solve real life problems.	Learn the subject with curiosity to understand new scientific developments.	Understand international perspective about mathematics.	Capability to use appropriate software's to solve mathematical equations.	Develop the protocols as per laboratory standards to accomplish the objectives.	Develop aptitude to formulate concepts based on fundamental axioms of mathematics.	Innovate, invent and solve complex mathematical problems using the knowledge of pure and applied mathematics.	Understand demands of the growing field of Mathematics by lifelong learning.	Develop problem-solving skills, critical thinking, and interest through assignments and project work.	Prepare students for competitive examinations such as NET, GATE, and many others.
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
BS MA 711 A	Advanced MATLAB Programming	2	3	3	2				3	3		3		3	2	

1=weakly mapped 2= moderately mapped 3=strongly mapped

Programme and Course Mapping																	
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1					**2**							**3**	**2**	**1**	**1**	**2**	**2**
CO2								**2**				**3**	**2**	**1**	**1**	**2**	**2**
CO3		**3**										**3**	**2**	**1**	**1**	**2**	**2**
CO4							**2**					**3**	**2**	**1**	**1**	**2**	**2**
CO5			**3**									**3**	**2**	**1**	**1**	**2**	**2**
CO6	**3**											**3**	**2**	**1**	**1**	**2**	**2**
1=lightly mapped 2= moderately mapped 3=strongly mapped																	

BSMA713A	PROBABILITY AND STATISTICS	L	T	P	C
Version 2.0		4	0	0	4
Total Contact Hours	60				
Pre-requisites/Exposure	Basic algebra				
Co-requisites	--				

Course Objectives

1 To understand probability theory at basic and advance level, random variables and also their convergences at weak and strong levels.
2 To solve probabilistic problems
3 To understand different probability distributions and their implementation at realistic models.
4 To understand the process of hypothesis testing.

Course Outcomes

On completion of this course, the students will be able to know

CO1 Concept of discrete and continuous random variables and their probability distributions.
CO2 Central Limit Theorem and its applications.
CO3 basic concepts of hypothesis testing, including framing of null and alternative hypothesis.
CO4 about important inferential aspects such as estimation, test of hypotheses and associated concepts.
CO5 about order statistics and associated distributions.
CO6 to obtain estimator of the population parameter on the basis of selected sample and study its properties.

Catalog Description

In this course, descriptive and inferential statistical concepts shall be explained at the beginner level. In addition, how probability is used in inferential statistics shall be demonstrated in real-world situations.

Course Content

UNIT-I **14 lecture hours**

Bayes' theorem

Sample spaces and probability, conditional probability and Bayes' theorem.

UNIT-II **16 lecture hours**

Distributions

Discrete distributions**:** Uniform, Bernoulli, Binomial, Negative binomial, Geometric and Poisson; Continuous distributions**:** Uniform, Gamma, Exponential, Chi-square, Beta and normal; Normal approximation to the binomial distribution. The Central Limit Theorem.

UNIT-III **14 lecture hours**

Measure of central tendency

Measures of central tendency, measures of dispersion, confidence interval, estimating a population proportion, estimating a population mean, estimating a population standard deviation or variance.

UNIT-IV **16 lecture hours**

Hypothesis testing

Steps in hypothesis testing, P-value method for hypothesis testing, Hypothesis test- t, Z and chi-square, analysis of variance (ANOVA).

Reference Books/Materials

1. W.W. Hines, D.C. Montgomery, D.M. Goldsman, and C.M. Borror; *Probability and Statistics in Engineering*; John Wiley & Sons.
2. E.J. Dudewicz & S.N. Mishra; *Modern Mathematical Statistics*, John Wiley &. Sons.
3. J.S. Milton and J.C. Arnold; *Introduction to Probability and Statistics*, McGraw-Hill.
4. H.J. Larsen; *Introduction to Probability Theory and Statistical Inference*, John Wiley &. Sons.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	10	10	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	concept of discrete and continuous random variables and their probability distributions.	**PO5**
CO2	Central Limit Theorem and its applications.	**PO6**
CO3	basic concepts of hypothesis testing, including framing of null and alternative hypothesis.	**PO2**
CO4	about important inferential aspects such as estimation, test of hypotheses and associated concepts.	**PO7**
CO5	about order statistics and associated distributions.	**PO4**
CO6	to obtain estimator of the population parameter on the basis of selected sample and study its properties.	**PO3**

		Encourage critical thinking to conduct scientific investigations in a biased manner without prejudiced assumptions.	Assist students in analyzing questions, formulating hypotheses, evaluating and validating findings, and drawing logical conclusions.	Prepare students for pursuing research or careers and to design methods to conduct investigations of complex societal and environmental issues.	Continue to acquire relevant knowledge and skills to evaluate the concepts and scientific developments to take up any challenge.	Enhance knowledge mobilization through increased application of mathematics.	Able to use the advance knowledge in consultancy to solve real life problems.	Learn the subject with curiosity to understand new scientific developments.	Understand international perspective about mathematics.	Capability to use appropriate software's to solve mathematical equations.	Develop the protocols as per laboratory standards to accomplish the objectives.	Develop aptitude to formulate concepts based on fundamental axioms of mathematics.	Innovate, invent and solve complex mathematical problems using the knowledge of pure and applied mathematics.	Understand demands of the growing field of Mathematics by lifelong learning.	Develop problem-solving skills, critical thinking, and interest through assignments and project work	Prepare students for competitive examinations such as NET, GATE, and many others.
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
BSMA713A	Probability and Statistics		3	3	2	2	2	3					3	1	3	

1=weakly mapped
2= moderately mapped
3=strongly mapped

Programme and Course Mapping																	
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	**2**											**3**	**2**	**1**	**1**	**2**	**2**
CO2								**2**				**3**	**2**	**1**	**1**	**2**	**2**
CO3		**3**										**3**	**2**	**1**	**1**	**2**	**2**
CO4				**2**								**3**	**2**	**1**	**1**	**2**	**2**
CO5			**3**									**3**	**2**	**1**	**1**	**2**	**2**
CO6	**3**											**3**	**2**	**1**	**1**	**2**	**2**
1=lightly mapped 2= moderately mapped 3=strongly mapped																	

BSMA771A	ADVANCED MATLAB PROGRAMMING LAB	L	T	P	C
Version 1.0		0	0	2	1
Total Contact Hours	15				
Pre-requisites/Exposure					
Co-requisites	MATLAB SOFTWARE				

Course Objectives

The purpose of these labs is to help students talk and write in meaningful ways about mathematics. Specifically to describe quantities and changes in quantities clearly in terms of context, to make rigorous arguments about how such quantities are related, and to make connections between these features in the contexts and on graphs

Course Outcomes

On completion of this course, the students will be able to

CO1. Test program output for accuracy using hand calculations and plotting the different type of the graphs.
CO2. Analyses, the applicability and accuracy of matrix numerical solutions to linear systems of equations.
CO3. Analyses and applied the matrix method for finding the higher power of the matrix.
CO4. Demonstrate understanding of common numerical programing for finding the solution of Laplace and Wave equations
CO5. Write efficient, well-documented MATLAB code and present numerical results in an informative way of different real-life problems.

Catalog Description

The course is aimed for working or experiential coding or conducting research in scientific computing. Covered topics in scientific computing will include numerical linear algebra, numerical optimization, ODEs, and PDEs. Participants will be introduced to advanced MATLAB features, syntaxes, and toolboxes not traditionally found in introductory courses. Material will be reinforced with in-lecture examples, demos, and homework assignment involving topics from scientific computing. MATLAB topics will be drawn from: advanced graphics (2D/3D plotting, graphics handles, publication quality graphics, animation), MATLAB tools (debugger, profiler), code optimization (vectorization, memory management), object-oriented programming, compiled MATLAB (MEX files and MATLAB coder), interfacing with external programs, toolboxes (optimization, parallel computing, symbolic math, PDEs). In exact, students learn how to apply the tools of calculus to a variety of problem situations.

List of practical

1.Compute the sum of n integers.
2. Find the factorial of n numbers.
3. Plot the graph of any function.
4. Solutions of simultaneous linear equations.
5. Solution of algebraic / transcendental equations.
6. To find the largest Eigen value of a matrix using power-method.
7. Inversion of matrices
8. Numerical differentiation
9. Numerical integration
10. Solution of ordinary differential equations
11. Statistical problems on central tendency and dispersion
12. Fitting of curves by least square method.
13. To find the numerical solution of Laplace equation.
14. To find the numerical solution of Wave equation

NOTE: Ten experiments are to be performed, out of which at least seven experiments should be performed from above list. Remaining three experiments may either be performed from the above list or designed & setup by the concerned person as per the scope of the syllabus.

Reference Books/Materials

1. Rudra Pratap; Getting Started with MATLAB 7, Oxford Press.
2. S.R. Otto and J.P. Denier, An Introduction to Programming and Numerical Methods in MATLAB, Springer.
3. Won Young Yang, Tae-Sang-Chung, John Morris; Applied numerical Methods using MATLAB, John Wiley and Sons.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Conduct of Experiment	Attendance	Lab Record/ Quiz/ Viva-Voce	End Term Practical Exam
Weightage (%)	20	10	20	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Test program output for accuracy using hand calculations and plotting the different type of the graphs	**PO9**
CO2	Analyses the applicability and accuracy of matrix numerical solutions to linear systems of equations	**PO9**
CO3	Analyses and applied the matrix method for finding the higher power of the matrix	**PO9**
CO4	Demonstrate understanding of common numerical programing for finding the solution of Laplace and Wave equations	**PO9**
CO5	Write efficient, well-documented MATLAB code and present numerical results in an informative way of different real-life problems.	**PO9**

		Encourage critical thinking to conduct scientific investigations in a biased manner without prejudiced assumptions.	Assist students in analyzing questions, formulating hypotheses, evaluating and validating findings, and drawing logical conclusions.	Prepare students for pursuing research or careers and to design methods to conduct investigations of complex societal and environmental issues.	Continue to acquire relevant knowledge and skills to evaluate the concepts and scientific developments to take up any challenge.	Enhance knowledge mobilization through increased application of mathematics.	Able to use the advance knowledge in consultancy to solve real life problems.	Learn the subject with curiosity to understand new scientific developments.	Understand international perspective about mathematics.	Capability to use appropriate software's to solve mathematical equations.	Develop the protocols as per laboratory standards to accomplish the objectives.	Develop aptitude to formulate concepts based on fundamental axioms of mathematics.	Innovate, invent and solve complex mathematical problems using the knowledge of pure and applied mathematics.	Understand demands of the growing field of Mathematics by lifelong learning.	Develop problem-solving skills, critical thinking, and interest through assignments and project work.	Prepare students for competitive examinations such as NET, GATE, and many others.
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
BS MA 771 A	Advanced MATLAB Programming-Lab									3	3	3	3	2	3	

1=weakly mapped
2= moderately mapped
3=strongly mapped

Programme and Course Mapping																	
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	**2**											**3**	**2**	**1**	**1**	**2**	**2**
CO2								**2**				**3**	**2**	**1**	**1**	**2**	**2**
CO3					**3**							**3**	**2**	**1**	**1**	**2**	**2**
CO4				**2**								**3**	**2**	**1**	**1**	**2**	**2**
CO5			**3**									**3**	**2**	**1**	**1**	**2**	**2**
CO6						**3**						**3**	**2**	**1**	**1**	**2**	**2**
1=lightly mapped 2= moderately mapped 3=strongly mapped																	

BSMA773A	PROBABILITY AND STATISTICS LAB	L	T	P	C
Version 1.0		0	0	2	1
Total Contact Hours	15				
Pre-requisites/Exposure	MS EXCEL				
Co-requisites	STATISTICAL SOFTWARE				

Course Objectives

1 To acquire knowledge of important discrete and continuous distributions such as Binomial, Poisson, Geometric, Negative Binomial and Hyper-geometric, normal, uniform, exponential, beta and gamma distributions.
2 To understand the concept of sampling distributions and their applications in statistical inference.
3 To understand the process of hypothesis testing.
4 To have a clear understanding of when to apply various tests of hypothesis about population parameters using sample statistics and draw appropriate conclusions from the analysis.

Course Outcomes

On completion of this course, the students will be able to

CO1 knowledge to conceptualize the probabilities of events including frequentist and axiomatic approach.
CO2 knowledge of various types of data, their organization and evaluation of summary measures such as measures of central tendency and dispersion etc.
CO3 knowledge of other types of data reflecting quality characteristics including concepts of independence and association between two attributes.
CO4 knowledge about inferences from Binomial, Poisson and Normal distributions as illustrations,
CO5 Hypothesis testing based on a single sample and two samples using both classical and p value approach.
CO6 Testing of significance and confidence intervals for single proportion and difference of two proportions

Catalog Description

This course aims to provide an understanding of the basic concepts in probability, conditional probability and independent events. It will also focus on the random variable, mathematical expectation, and different types of univariate and bivariate distributions. In this course, student will learn how to describe relationships between two numerical quantities and characterized these relationships graphically, in the form of summary statistics, and through simple linear regression models.

Course Content

List of Practicals

1. Graphical representation of data.
2. Problems based on measures of central tendency.
3. Problems based on measures of dispersion.
4. Problems based on combined mean and variance and coefficient of variation.
5. Problems based on moments, skewness and kurtosis.
6. Fitting of polynomials, exponential curves.
7. Testing of significance and confidence intervals for single proportion and difference of two proportions
8. Fitting of binomial distributions for n and p = q = ½.
9. Fitting of binomial distributions for given n and p.
10. Fitting of binomial distributions after computing mean and variance.
11. Fitting of Poisson distributions for given value of lambda.
12. Fitting of Poisson distributions after computing mean.
13. Fitting of negative binomial.
14. Application problems based on binomial distribution.
15. Application problems based on Poisson distribution.
16. Application problems based on negative binomial distribution.
17. Problems based on area property of normal distribution.
18. To find the ordinate for a given area for normal distribution.
19. Application based problems using normal distribution.
20. Fitting of normal distribution when parameters are given.
21. Fitting of normal distribution when parameters are not given.
22. Fitting of Binomial, Poisson distribution and apply Chi-square test for goodness of fit

Reference Books/Materials

1. Robert V. Hogg, Joseph W. McKean & Allen T. Craig (2013). *Introduction to Mathematical Statistics* (7th edition), Pearson Education.
2. Irwin Miller &Marylees Miller (2014). *John E. Freund's Mathematical Statistics with Applications* (8thedition). Pearson. Dorling Kindersley Pvt. Ltd. India.
3. Jim Pitman (1993). *Probability*, Springer-Verlag.
4. Sheldon M. Ross (2014). *Introduction to Probability Models* (11th edition). Elsevier.
5. A. M. Yaglom and I. M. Yaglom (1983). *Probability and Information*. D. Reidel Publishing Company. Distributed by Hindustan Publishing Corporation (India) Delhi.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	**Conduct of Experiment**	**Attendance**	**Lab Record/ Quiz/Viva-Voce**	**End Term Practical Exam**
Weightage (%)	**20**	**10**	**20**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	knowledge to conceptualize the probabilities of events including frequentist and axiomatic approach.	**PO1**
CO2	knowledge of various types of data, their organization and evaluation of summary measures such as measures of central tendency and dispersion etc.	**PO10**
CO3	knowledge of other types of data reflecting quality characteristics including concepts of independence and association between two attributes.	**PO3**
CO4	knowledge about inferences from Binomial, Poisson and Normal distributions as illustrations,	**PO9**
CO5	Hypothesis testing based on a single sample and two samples using both classical and p value approach.	**PO2**
CO6	Testing of significance and confidence intervals for single proportion and difference of two proportions	**PO4**

		Encourage critical thinking to conduct scientific investigations in a biased manner without prejudiced assumptions.	Assist students in analyzing questions, formulating hypotheses, evaluating and validating findings, and drawing logical conclusions.	Prepare students for pursuing research or careers and to design methods to conduct investigations of complex societal and environmental issues.	Continue to acquire relevant knowledge and skills to evaluate the concepts and scientific developments to take up any challenge.	Enhance knowledge mobilization through increased application of mathematics.	Able to use the advance knowledge in consultancy to solve real life problems.	Learn the subject with curiosity to understand new scientific developments.	Understand international perspective about mathematics.	Capability to use appropriate software's to solve mathematical equations.	Develop the protocols as per laboratory standards to accomplish the objectives.	Develop aptitude to formulate concepts based on fundamental axioms of mathematics.	Innovate, invent and solve complex mathematical problems using the knowledge of pure and applied mathematics.	Understand demands of the growing field of Mathematics by lifelong learning.	Develop problem-solving skills, critical thinking, and interest through assignments and project work	Prepare students for competitive examinations such as NET, GATE, and many others.
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
BSMA773A	Probability and Statistics Lab	2	3	2	3					3	3	1		2	2	

1=weakly mapped

2= moderately mapped

3=strongly mapped

Programme and Course Mapping																	
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	**2**											**3**	**2**	**1**	**1**	**2**	**2**
CO2								**2**				**3**	**2**	**1**	**1**	**2**	**2**
CO3		**3**										**3**	**2**	**1**	**1**	**2**	**2**
CO4				**2**								**3**	**2**	**1**	**1**	**2**	**2**
CO5			**3**									**3**	**2**	**1**	**1**	**2**	**2**
CO6	**3**											**3**	**2**	**1**	**1**	**2**	**2**
1=lightly mapped 2= moderately mapped 3=strongly mapped																	

Semester II

BSMA702A	ABSTRACT ALGEBRA - I	L	T	P	C
Version 1.0		4	0	0	4
Total Contact Hours	60				
Pre-requisites/Exposure	Group Theory				
Co-requisites	--				

Course Objectives:

The course will enable the students to:

1. Understand some more advanced concepts in group theory.
2. Describe finite groups of order upto 15.
3. Know the fundamental concepts in ring theory such as Extension of fields
4. Learn in detail about Galois theory and insolvability of polynomials

Course Outcomes:

On completion of this course, the students will be able to

CO1. Understand the concept of normal and subnormal series
CO2. Connect Sylow theorems with simple applications
CO3. Apply the notions Splitting fields, Algebraically closed fields, Perfect fields.
CO4. Understand Galois extensions, Normal extensions and their properties

Catalogue Description:

This course particularly deals with some more advanced algebra concepts, and it is laid on a preliminary course in algebra. The course begins with concepts of normal and subnormal series with definition and examples of it. Sylow's theorems with simple applications are the key concepts in this learning programme. Moreover, the concept of field extensions and some concepts from insolvability of polynomials are also considered in the plan of action.

Course Content

Unit I: **14 lecture hours**

Groups

Groups : Zassenhaus lemma, Normal and subnormal series, Composition series, Jordan- Holder theorem, Solvable series, Derived series, Solvable groups, Solvability of Sn – the symmetric group of degree $n \geq 2$.

Unit II: **16 lecture hours**

Sylow Groups

Nilpotent group: Central series, Nilpotent groups and their properties, Equivalent conditions for a finite group to be nilpotent, Upper and lower central series, Sylow-p sub groups, Sylow theorems with simple applications. Description of group of order p2 and pq, where p and q are distinct primes (In general survey of groups upto order 15).

Unit III: **14 lecture hours**

Fields

Field theory, Extension of fields, algebraic and transcendental extensions. Splitting fields, Separable and inseparable extensions, Algebraically closed fields, Perfect fields.

Unit IV: **16 lecture hours**

Galois theory

Finite fields, Automorphism of extensions, Fixed fields, Galois extensions, Normal extensions and their properties, Fundamental theorem of Galois theory, Insolvability of the general polynomial of degree $n \geq 5$ by radicals. Text Books

Textbooks

1. Michael Artin (2014). Algebra (2nd edition). Pearson.
2. P. B. Bhattacharya, S. K. Jain & S. R. Nagpaul (2003). Basic Abstract Algebra (2nd edition). Cambridge University Press.

Reference Books/Materials

3. I. N. Herstein (2006). Topics in Algebra (2nd edition). Wiley India.
4. David S. Dummit & Richard M. Foote (2008). Abstract Algebra (2nd edition). Wiley.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination/ Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	10	10	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Understand the concept of normal and subnormal series	**PO2**
CO2	Connect Sylow's theorems with simple applications	**PO5**
CO3	Apply the notions Splitting fields, Algebraically closed fields, Perfect fields.	**PO10**
CO4	Understand Galois extensions, Normal extensions and their properties	**PO3**

		Encourage critical thinking to conduct scientific investigations in a biased manner without prejudiced assumptions.	Assist students in analyzing questions, formulating hypotheses, evaluating and validating findings, and drawing logical conclusions.	Prepare students for pursuing research or careers and to design methods to conduct investigations of complex societal and environmental issues.	Continue to acquire relevant knowledge and skills to evaluate the concepts and scientific developments to take up any challenge.	Enhance knowledge mobilization through increased application of mathematics.	Able to use the advance knowledge in consultancy to solve real life problems.	Learn the subject with curiosity to understand new scientific developments.	Understand international perspective about mathematics.	Capability to use appropriate software's to solve mathematical equations.	Develop the protocols as per laboratory standards to accomplish the objectives.	Develop aptitude to formulate concepts based on fundamental axioms of mathematics.	Innovate, invent and solve complex mathematical problems using the knowledge of pure and applied mathematics.	Understand demands of the growing field of Mathematics by lifelong learning.	Develop problem-solving skills, critical thinking, and interest through assignments and project work	Prepare students for competitive examinations such as NET, GATE, and many others.
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
BSMA 702A	Abstract Algebra - I			3	3			2	3				3		2	

1=weakly mapped

2= moderately mapped

3=strongly mapped

Programme and Course Mapping																	
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1					**2**							**3**	**2**	**1**	**1**	**2**	**2**
CO2								**2**				**3**	**2**	**1**	**1**	**2**	**2**
CO3		**3**										**3**	**2**	**1**	**1**	**2**	**2**
CO4				**2**								**3**	**2**	**1**	**1**	**2**	**2**
CO5						**3**						**3**	**2**	**1**	**1**	**2**	**2**
CO6	**3**											**3**	**2**	**1**	**1**	**2**	**2**
1=lightly mapped 2= moderately mapped 3=strongly mapped																	

BSMA704A	TOPOLOGY	L	T	P	C
Version 2.0		4	0	0	4
Total Contact Hours	60				
Pre-requisites/Exposure	Graduate level knowledge of mathematical analysis				
Co-requisites	--				

Course Objectives

After successful completion of this course students will be able to

1. Continue more advanced study in this area.
2. Understand different types of topological spaces and their properties.
3. Differentiate between Net and Filters.
4. Differentiate between compact and complete topological spaces.

Course Outcomes

On completion of this course, the students will be able to

CO1. Remember and understand important concepts of Closed sets, Closure, dense sets. neighbourhoods, interior, exterior, and boundary points, accumulation points, derived sets,bases and sub-bases,subspaces and relative topology.
CO2. Apply these concepts on other interrelated topics.
CO3. Analyze and correlate difference between theorem, lemma and corollary.
CO4. Solve problems based upon Net and Filter.

Catalog Description

This course imparts the basic concepts of topological spaces and their properties. It enables students to differentiate between Net and Filter. This course helps students in variety of ways to solve the problems based upon compact and complete metric space. The course introduces the basic concepts about separable space.

Course Content

Unit I: **14 lecture hours**

Topological Spaces

Definition and examples of topological spaces. Closed sets. Closure. Dense sets. neighborhoods, interior, exterior, and boundary. Accumulation points and derived sets. Bases and sub-bases. Subspaces and relative topology. Alternative methods of defining a topology in terms of Kuratowski closure operator and neighborhood systems.

Unit II: **16 lecture hours**

Separation Axioms

Continuous functions and homeomorphism. First and second countable space. Lindelöf spaces. Separable spaces.The separation axioms T0, T1, T2, T3½, T4; their characterizations and basic properties. Urysohn's lemma. Tietze extension theorem.

Unit III: **16 lecture hours**

Compactness and Connectedness

Compactness. Basic properties of compactness. Compactness and finite intersection property. Sequential, countable, and B-W compactness. Local compactness. One-point compactification. Connected spaces and their basic properties. Connectedness of the real line. Components. Locally connected spaces.

Unit IV: **14 lecture hours**

Tycho off Product Topology

Tychonoff product topology in terms of standard sub-base and its characterizations. Product topology and separation axioms, connected-ness, and compactness (incl. the Tychonoff's theorem), product spaces.Nets and filters, their convergence, and interrelation. Hausdorffness and compactness in terms of net/filter convergence.

Textbooks

1. George F. Simmons, Introduction to Topology and Modern Analysis, McGraw-Hill.
2. J. L. Kelley, General Topology, Van Nostrand,
3. K. D. Joshi, Introduction to General Topology, Wiley Eastern.
4. James R. Munkres, Topology, 2nd Edition, Pearson International.
5. J. Dugundji, Topology, Prentice-Hall of India, 1966.
6. N. Bourbaki, General Topology, Part I, Addison-Wesley.
7. S. Willard, General Topology, Addison-Wesley.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	10	10	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Remember and understand important concepts of Closed sets, Closure, dense sets. neighborhoods, interior, exterior, and boundary points,accumulation points ,derived sets,bases and sub-bases,subspaces and relative topology	**PO1,PO7**
CO2	Apply these concepts on other interrelated topics.	**PO5,PO7**
CO3	Analyze and correlate difference between theorem, lemma and corollary.	**PO8,PO7**
CO4	Solve problems based upon Net and Filter.	**PO4,PO7**

		Encourage critical thinking to conduct scientific investigations in a biased manner without prejudiced assumptions.	Assist students in analyzing questions, formulating hypotheses, evaluating and validating findings, and drawing logical conclusions.	Prepare students for pursuing research or careers and to design methods to conduct investigations of complex societal and environmental issues.	Continue to acquire relevant knowledge and skills to evaluate the concepts and scientific developments to take up any challenge.	Enhance knowledge mobilization through increased application of mathematics.	Able to use the advance knowledge in consultancy to solve real life problems.	Learn the subject with curiosity to understand new scientific developments.	Understand international perspective about mathematics.	Capability to use appropriate software's to solve mathematical equations.	Develop the protocols as per laboratory standards to accomplish the objectives.	Develop aptitude to formulate concepts based on fundamental axioms of mathematics.	Innovate, invent and solve complex mathematical problems using the knowledge of pure and applied mathematics.	Understand demands of the growing field of Mathematics by lifelong learning.	Develop problem-solving skills, critical thinking, and interest through assignments and project work	Prepare students for competitive examinations such as NET, GATE, and many others.
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
BSMA 704A	Topology	2			2	2	2	3	1			2	3	1	3	3

1=weakly mapped
2= moderately mapped
3=strongly mapped

Programme and Course Mapping																	
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	**2**											**3**	**2**	**1**	**1**	**2**	**2**
CO2								**2**				**3**	**2**	**1**	**1**	**2**	**2**
CO3		**3**										**3**	**2**	**1**	**1**	**2**	**2**
CO4				**2**								**3**	**2**	**1**	**1**	**2**	**2**
CO5			**3**									**3**	**2**	**1**	**1**	**2**	**2**
CO6	**3**											**3**	**2**	**1**	**1**	**2**	**2**
1=lightly mapped 2= moderately mapped 3=strongly mapped																	

BSMA706A	COMPLEX ANLAYSIS	L	T	P	C
Version 1.0		4	0	0	4
Total Contact Hours	60				
Pre-requisites/Exposure					
Co-requisites	--				

Course Objectives

1. Provide the brief knowledge of Complex Function and analytic function.
2. To understand and find the intregral of the Complex function.
3. Solve the problems related to the pole, zeros and residues.
4. Recognize the series, bilinear transformation and apply their properties to solve real file problems.
5. Apply conformal mapping appearing in social sciences, physical sciences, life sciences and a host of other disciplines.

Course Outcomes

On completion of this course, the students will be able to

CO.1 Applied analytic function and its properties to solve different type of problems.
CO2. Recognize the higher order derivate and apply the Cauchy integral formula to solve different type of the problems.
CO3. Determine and solve the problems related to the pole, zeros and residues.
CO4. Recognize the bilinear transformation and apply their properties to solve real file problems.
CO5: Determine the concept of conformal mapping to solve complex and critical problems.

Catalogue Description

Complex analysis is indeed a beautiful and useful branch of mathematics. It is one of the classical subjects with most of the main results extending back into the nineteenth century and earlier. Yet, the subject is far from dormant. It is a launching point for many areas of research and it continues to find new areas of applicability, from pure mathematics to applied physics. Many of the giants of mathematics have contributed to the development of complex analysis. Important objectives of the Complex analysis is to develop and strengthen the students' problem-solving skills and to teach them to read, write, speak, and think in the language of mathematics. In particular, students learn how to apply the tools of calculus to a variety of problem situations.

Course Content

Unit I: **16 lecture hours**

Complex Variable: Function of a complex variable, continuity, differentiability. Analytic functions and their properties, Cauchy-Riemann equations in Cartesian and polar coordinates, Power series, Radius of convergence, Differentiability of sum function of a power series.

Path in a region, smooth path, p.w. smooth path, contour, simply connected region, multiply connected region, bounded variation, total variation, complex integration, Cauchy-Goursat theorem, Cauchy theorem for simply and multiply connected domains.

Unit II: **16 lecture hours**

Complex Integration: Cauchy integral formula. Extension of Cauchy integral formula for multiple connected domain. Higher order derivative of Cauchy integral formula. Gauss mean value theorem Morera's theorem. Cauchy's inequality. Zeros of an analytic function, entire function, radius of convergence of an entire function, Liouville's theorem, Fundamental theorem of algebra, Taylor's theorem.

Unit III: **14 lecture hours**

Complex Series and Residue: Maximum modulus principle, Minimum modulus principle. Schwarz Lemma. Singularity, their classification, pole of a function and its order. Laurent series, Cassorati – Weiertrass theorem Meromorphic functions, Poles and zeros of Meromorphic functions. The argument principle, Rouche's theorem, inverse function theorem Residue at a singularity, residue at a simple pole, residue at infinity. Cauchy residue theorem and its use to calculate certain integrals.

Unit IV: **14 lecture hours**

Complex transformation and mapping: Bilinear transformation, their properties and classification, cross ratio, preservance of cross ratio under bilinear transformation, preservance of circle and straight line under bilinear transformation, fixed point bilinear transformation, normal form of a bilinear transformation. Definition and examples of conformal mapping, critical points.

Textbooks

1. (AR) A.R. Vashisth, Complex Analysis, krishana prakashan Media, Meerut, 1942.i.

Reference Books/Materials

1. J. B. Conway, Functions of One Complex Variable, 2nd ed., Narosa, New Delhi.
2. T.W. Gamelin, Complex Analysis, Springer International Edition.
3. R. Remmert, Theory of Complex Functions, Springer Verlag.
4. A.R. Shastri, An Introduction to Complex Analysis, Macmilan India, New Delhi.
5. Shanti Narayan; Theory of Functions of a complex variable, S. Chand & Co.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	10	10	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	Mapped Program Outcomes
CO1	Applied analytic function and its properties to solve different type of problems.	PO1
CO2	Recognize the higher order derivate and apply the Cauchy integral formula to solve different type of the problems.	PO8
CO3	Determine and solve the problems related to the pole, zeros and residues.	PO2
CO4	Recognize the series, bilinear transformation and apply their properties to solve real file problems.	PO4
CO5	Determine the concept of conformal mapping to solve complex and critical problems.	PO3

		Encourage critical thinking to conduct scientific investigations in a biased manner without prejudiced assumptions.	Assist students in analyzing questions, formulating hypotheses, evaluating and validating findings, and drawing logical conclusions.	Prepare students for pursuing research or careers and to design methods to conduct investigations of complex societal and environmental issues.	Continue to acquire relevant knowledge and skills to evaluate the concepts and scientific developments to take up any challenge.	Enhance knowledge mobilization through increased application of mathematics.	Able to use the advance knowledge in consultancy to solve real life problems.	Learn the subject with curiosity to understand new scientific developments.	Understand international perspective about mathematics.	Capability to use appropriate software's to solve mathematical equations.	Develop the protocols as per laboratory standards to accomplish the objectives.	Develop aptitude to formulate concepts based on fundamental axioms of mathematics.	Innovate, invent and solve complex mathematical problems using the knowledge of pure and applied mathematics.	Understand demands of the growing field of Mathematics by lifelong learning.	Develop problem-solving skills, critical thinking, and interest through assignments and project work.	Prepare students for competitive examinations such as NET, GATE, and many others.
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
BSMA706A	Complex Analysis	2	3	3	2				2			3		3	2	

1=weakly mapped

2= moderately mapped

3=strongly mapped

Programme and Course Mapping																	
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	**2**											**3**	**2**	**1**	**1**	**2**	**2**
CO2								**2**				**3**	**2**	**1**	**1**	**2**	**2**
CO3					**3**							**3**	**2**	**1**	**1**	**2**	**2**
CO4		**2**										**3**	**2**	**1**	**1**	**2**	**2**
CO5			**3**									**3**	**2**	**1**	**1**	**2**	**2**
CO6	**3**											**3**	**2**	**1**	**1**	**2**	**2**
1=lightly mapped 2= moderately mapped 3=strongly mapped																	

BSMA708A	ADVANCED ORDINARY DIFFERENTIAL EQUATIONS	L	T	P	C
Version 1.0		4	0	0	4
Total Contact Hours	60				
Pre-requisites/Exposure	Ordinary Differential Equations				
Co-requisites	--				

Course Objectives

1 To identify classes of non-linear ordinary differential equations.
2 To apply an appropriate method for the solution of ordinary differential equations
3 To analyze qualitative properties of systems of ordinary differential equations.
4 To develop ability to solve method of describing limiting behavior and asymptotic analysis to build numerical methods to approximate equation solutions.

Course Outcomes

On completion of this course, the students will be able to know

CO1 Solution methods for first order as well as second order equations
CO2 Existence and Uniqueness of Initial Value Problems
CO3 Higher Order Linear Equations and linear Systems
CO4 Two Dimensional Autonomous Systems and Phase Space Analysis
CO5 Asymptotic Behavior
CO6 Boundary Value Problems for Second Order Equations

Catalog Description

The course prepares students to do independent work at the frontiers of linear and non-linear systems and determine the location, type, and stability of all critical points by finding the eigenvalues of the linearized system graphically and analytically. The course builds further on qualitative behaviour of the solution vis-a-vis orbits and phase plane portraits. Students learns to formulate and find solutions to more complex mathematical problems encountered in the applied sciences and engineering involving differential equations and appreciate fundamental limitations in control systems.

Course Content

Unit I **14 lecture hours**

Power Series Methods

Review of solution methods for first order as well as second order equations, Power Series methods with properties of Bessel functions and Legendre polynomials.

Unit II **14 lecture hours**

Existence and Uniqueness of IVP

Existence and Uniqueness of Initial Value Problems: Picard's and Peano's Theorems, Gronwall's inequality, continuation of solutions and maximal interval of existence, continuous dependence.

Higher Order Linear Equations and linear Systems: fundamental solutions, Wronskian, variation of constants, matrix exponential solution, behaviour of solutions.

Unit III **14 lecture hours**

Two Dimensional Autonomous Systems

Two Dimensional Autonomous Systems and Phase Space Analysis: critical points, proper and improper nodes, spiral points and saddle points.

Asymptotic Behavior: stability (linearized stability and Lyapunov methods).

Unit IV **14 lecture hours**

BVP of Second Order

Boundary Value Problems for Second Order Equations: Green's function, Sturm comparision theorems and oscillations, eigenvalue problems.

Reference Books/Materials

1. M. Hirsch, S. Smale and R. Deveney; *Differential Equations, Dynamical Systems and Introduction to Chaos*, Academic Press.
2. L. Perko; *Differential Equations and Dynamical Systems, Texts in Applied Mathematics*, Vol. 7, 2nd ed., Springer Verlag, New York.
3. M. Rama Mohana Rao; *Ordinary Differential Equations: Theory and Applications*, Affiliated East-West Press Pvt. Ltd., New Delhi.
4. D. A. Sanchez; *Ordinary Differential Equations and Stability Theory: An Introduction*, Dover Publ. Inc., New York, 1968.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	10	10	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Solution methods for first order as well as second order equations	**PO1**
CO2	Existence and Uniqueness of Initial Value Problems	**PO6**
CO3	Higher Order Linear Equations and linear Systems	**PO7**
CO4	Two Dimensional Autonomous Systems and Phase Space Analysis	**PO9**
CO5	Asymptotic Behaviour	**PO2**
CO6	Boundary Value Problems for Second Order Equations	**PO3**

		Encourage critical thinking to conduct scientific investigations in a biased manner without prejudiced assumptions.	Assist students in analyzing questions, formulating hypotheses, evaluating and validating findings, and drawing logical conclusions.	Prepare students for pursuing research or careers and to design methods to conduct investigations of complex societal and environmental issues.	Continue to acquire relevant knowledge and skills to evaluate the concepts and scientific developments to take up any challenge.	Enhance knowledge mobilization through increased application of mathematics.	Able to use the advance knowledge in consultancy to solve real life problems.	Learn the subject with curiosity to understand new scientific developments.	Understand international perspective about mathematics.	Capability to use appropriate software's to solve mathematical equations.	Develop the protocols as per laboratory standards to accomplish the objectives.	Develop aptitude to formulate concepts based on fundamental axioms of mathematics.	Innovate, invent and solve complex mathematical problems using the knowledge of pure and applied mathematics.	Understand demands of the growing field of Mathematics by lifelong learning.	Develop problem-solving skills, critical thinking, and interest through assignments and project work	Prepare students for competitive examinations such as NET, GATE, and many others.
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
BSMA708A	Advanced Ordinary Differential Equations	3	2	2			2	3		3			3	2		2

1=weakly mapped 2= moderately mapped 3=strongly mapped

Programme and Course Mapping																	
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	**2**											**3**	**2**	**1**	**1**	**2**	**2**
CO2								**2**				**3**	**2**	**1**	**1**	**2**	**2**
CO3		**3**										**3**	**2**	**1**	**1**	**2**	**2**
CO4				**2**								**3**	**2**	**1**	**1**	**2**	**2**
CO5			**3**									**3**	**2**	**1**	**1**	**2**	**2**
CO6	**3**											**3**	**2**	**1**	**1**	**2**	**2**
1=lightly mapped 2= moderately mapped 3=strongly mapped																	

BSMA712A	NUMERICAL ANALYSIS	L	T	P	C
Version 1.0		4	0	0	4
Total Contact Hours	60				
Pre-requisites/Exposure					
Co-requisites	--				

Course Objectives

1. Derive appropriate numerical methods to solve algebraic and transcendental equations
2. Approximate a function using various interpolation techniques.
3. To find the numerical solution of initial value problems and boundary value problems
4. Familiar with numerical integration and differentiation, numerical solution of ordinary differential equations and Partial differential equations

Course Outcomes

This course will enable the students to:

CO1. Approximate a function using an appropriate numerical method in various research problems

CO2. Solve algebraic and transcendental equation using an appropriate numerical method

CO3. Learn about various interpolating and extrapolating methods.

CO4. Evaluate derivative at a value using an appropriate numerical method in various research problems.

CO5. Solve differential equation numerically.

Catalog Description

This course will emphasize the development of numerical algorithms to provide solutions to common problems formulated in science and engineering. The primary objective of the course is to develop the basic understanding of the construction of numerical algorithms, and perhaps more importantly, the applicability and limits of their appropriate use. Acquire the ability to calculate and reason to design complex and critical financial models for any organization and after completing this course students apply the mathematical modeling and reasoning to solve basic problems. To develop the mathematical skills of the students in the areas of numerical methods

Course Content

Unit I: 14 lecture hours

Solution of Algebraic and Transcendental Equations

Iterative Methods, Bisection Method, Method of false position, Secant Method, Newton-Raphson Method, Muller's Method, Horner's Method, Lin-Bairstow's Method and Graeffe's Root squaring Method. Solution of Simultaneous Algebraic Equations: Direction methods, Matrix inversion method, Guass elimination, Gauss-Jordan method, Factorization method; Iterative method- Jacobi and Seidal Methods, Relaxation Method.

Unit II: **16 lecture hours**

Interpolation

Newton's Interpolation, Gauss's interpolation, Stirling's formula, Bessel's formula, Everett's formula, Lagranges's interpolation, Divided Differences and Newton's divided difference formula, Hermite's interpolation, Spline interpolation, Double interpolation, Inverse interpolation.

Unit III: **16 lecture hours**

Numerical Differentiation and Integration

Formulae for derivatives, Maxima and Minima of a tabulated function, Newton-Cote's Quadrature Formula, Romberg's Method, Euler-Maclaurin formula, Gaussian integration, Numerical double integration. Numerical Solution of Ordinary Differential Equations: Picard's Method, Taylor's series method, Euler's Method, Modified Euler's Method, Runge-Kutta Method, Milne's Predictor-Corrector Method, Adams-Bashforth method, Solving simultaneous first order differential equations and second order differential equations. Error analysis, Stability analysis, Boundary-value problems, Finite-difference method, Shooting method.

Unit IV: **14 lecture hours**

Numerical Solution of Partial Differential Equations

Finite – difference approximations to partial derivatives, Solutions of Laplace equation, Poisson's equation, Five point formulae for Laplacian, Concept of compatibility, convergence and stability, explicit, full implicit, Crank-Nicholson, du-Fort and Frankel scheme, ADI methods to solve two-dimensional equations with error analysis.

Textbooks

1. M. K. Jain, S. R. K. Iyengar and R. K. Jain; *Numerical Methods for Scientific and Engineering Computation*, New age International Publisher, India.
2. Kresyzig; *Advanced Engineering Mathematics*, John Wiley and Sons.
3. Veerarajan and Ramachandran, Numerical Methods: With Programs In C, Tata McGraw-Hill Education.

Reference Books/Materials

1.B. S. Grewal, *Numerical Methods in Engineering and Science*, Khanna Publishers.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	10	10	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	Mapped Program Outcomes
CO1	Approximate a function using an appropriate numerical method in various research problems	PO4
CO2	Solve algebraic and transcendental equation using an appropriate numerical method	PO5
CO3	Learn about various interpolating and extrapolating methods	PO3
CO4	Evaluate derivative at a value using an appropriate numerical method in various research problems	PO9
CO5	Solve differential equation numerically.	PO10

		Encourage critical thinking to conduct scientific investigations in a biased manner without prejudiced assumptions.	Assist students in analyzing questions, formulating hypotheses, evaluating and validating findings, and drawing logical conclusions.	Prepare students for pursuing research or careers and to design methods to conduct investigations of complex societal and environmental issues.	Continue to acquire relevant knowledge and skills to evaluate the concepts and scientific developments to take up any challenge.	Enhance knowledge mobilization through increased application of mathematics.	Able to use the advance knowledge in consultancy to solve real life problems.	Learn the subject with curiosity to understand new scientific developments.	Understand international perspective about mathematics.	Capability to use appropriate software's to solve mathematical equations.	Develop the protocols as per laboratory standards to accomplish the objectives.	Develop aptitude to formulate concepts based on fundamental axioms of mathematics.	Innovate, invent and solve complex mathematical problems using the knowledge of pure and applied mathematics.	Understand demands of the growing field of Mathematics by lifelong learning.	Develop problem-solving skills, critical thinking, and interest through assignments and project work	Prepare students for competitive examinations such as NET, GATE, and many others.
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
BSMA712A	Numerical Analysis			2	2	3				2	3		2			3

1=weakly mapped

2= moderately mapped

3=strongly mapped

Programme and Course Mapping																	
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	**2**											**3**	**2**	**1**	**1**	**2**	**2**
CO2								**2**				**3**	**2**	**1**	**1**	**2**	**2**
CO3					**3**							**3**	**2**	**1**	**1**	**2**	**2**
CO4				**2**								**3**	**2**	**1**	**1**	**2**	**2**
CO5			**3**									**3**	**2**	**1**	**1**	**2**	**2**
CO6	**3**											**3**	**2**	**1**	**1**	**2**	**2**
1=lightly mapped 2= moderately mapped 3=strongly mapped																	

BSMA772A	NUMERICAL ANALYSIS LAB	L	T	P	C
Version 1.0		0	0	2	1
Total Contact Hours	15				
Pre-requisites/Exposure					
Co-requisites	MATLAB SOFTWARE				

Course Objectives

This course is an introduction to a broad range of numerical methods for solving mathematical problems that arise in Science and Engineering. The goal is to provide a basic understanding of the derivation, analysis, and use of these numerical methods, along with a rudimentary understanding of finite precision arithmetic and the conditioning and stability of the various problems and methods. This will help you choose, develop and apply the appropriate numerical techniques for your problem, interpret the results, and assess accuracy .The purpose of these labs is to develop the mathematical skills of the students in the areas of numerical methods, The explaining and understanding of the several available methods to Solve the simultaneous equations, Perform statistical data analysis, data interpolation by MATLAB and to calculate the numerical integration and differentiation, numerical solution of differential equation with MATLAB

Course Outcomes

On completion of this course, the students will be able to

CO1. To develop the mathematical skills of the students in the areas of numerical methods

CO2. The explaining and understanding of the several available methods to Solve the simultaneous equations

CO3. Perform statistical data analysis, data interpolation by MATLAB

CO4. To calculate the numerical integration and differentiation, numerical solution of differentiation equation with MATLAB

Catalog Description

This Lab Course takes up the problems of practical that arise in various area of mathematics such as solving algebraic or differential equation. Lab experiments will be set in consonance with materials covered in the theory. Implementation of numerical techniques using MATLAB.

Course Content

List of practical

1. Bisection Method.
2. Newton Raphson Method.
3. Secant Method.
4. Regulai Falsi Method.
5. LU decomposition Method.
6. Gauss-Jacobi Method.
7. SOR Method or Gauss-Siedel Method.
8. Lagrange Interpolation.
9. Newton Interpolation.

10. Trapezoidal rule.
11. Simpson's rule.
12. Modified Euler's Method.
13. Runge-Kutta Method.
14. Milne's Predictor-Corrector Method.
15. Poisson's equation
16. First-order quasi-linear PDEs.
17. 3-D Heat Equation
18. Laplace equation of heat equilibrium problem

Textbooks

1. B. S. Grewal, *Numerical Methods in Engineering and Science*, Khanna Publishers.

2. M. K. Jain, S. R. K. Iyengar and R. K. Jain; *Numerical Methods for Scientific and Engineering Computation*, New age International Publisher, India

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Conduct of Experiment	Attendance	Lab Record/ Quiz/ Viva-Voce	End Term Practical Exam
Weightage (%)	**20**	**10**	**20**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	To develop the mathematical skills of the students in the areas of numerical methods	**PO9**
CO2	The explaining and understanding of the several available methods to Solve the simultaneous equations.	**PO10**
CO3	Perform statistical data analysis, data interpolation by MATLAB.	**PO9**
CO4	To calculate the numerical integration and differentiation, numerical solution of differentiation equation with MATLAB	**PO9**

		Encourage critical thinking to conduct scientific investigations in a biased manner without prejudiced assumptions.	Assist students in analyzing questions, formulating hypotheses, evaluating and validating findings, and drawing logical conclusions.	Prepare students for pursuing research or careers and to design methods to conduct investigations of complex societal and environmental issues.	Continue to acquire relevant knowledge and skills to evaluate the concepts and scientific developments to take up any challenge.	Enhance knowledge mobilization through increased application of mathematics.	Able to use the advance knowledge in consultancy to solve real life problems.	Learn the subject with curiosity to understand new scientific developments.	Understand international perspective about mathematics.	Capability to use appropriate software's to solve mathematical equations.	Develop the protocols as per laboratory standards to accomplish the objectives.	Develop aptitude to formulate concepts based on fundamental axioms of mathematics.	Innovate, invent and solve complex mathematical problems using the knowledge of pure and applied mathematics.	Understand demands of the growing field of Mathematics by lifelong learning.	Develop problem-solving skills, critical thinking, and interest through assignments and project work	Prepare students for competitive examinations such as NET, GATE, and many others.
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
BSMA772A	Numerical Analysis lab									3	3	3	3	2		2

Programme and Course Mapping																
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	**2**											**3**	**2**	**1**	**1**	**2**	**2**
CO2								**2**				**3**	**2**	**1**	**1**	**2**	**2**
CO3		**3**										**3**	**2**	**1**	**1**	**2**	**2**
CO4				**2**								**3**	**2**	**1**	**1**	**2**	**2**
CO5			**3**									**3**	**2**	**1**	**1**	**2**	**2**
CO6	**3**											**3**	**2**	**1**	**1**	**2**	**2**
1=lightly mapped 2= moderately mapped 3=strongly mapped																	

1=weakly mapped
2= moderately mapped
3=strongly mapped

BSMA776A	LaTeX LAB	L	T	P	C
Version 1.0		0	0	2	1
Total Contact Hours	15				
Pre-requisites/Exposure					
Co-requisites	--				

Course Objectives

The objective of the course is

1. To learn about a document preparation system for high-quality typesetting
2. To learn typesetting of complex mathematical formulas

Course Outcomes

On completion of this course, the students will be able to

CO1. Typesetting journal articles, technical reports, books, and slide presentations.
CO2. Control over large documents containing sectioning, cross-references
CO3. Automatic generation of bibliographies and indexes

Catalog Description

The course aims to introduce students to LaTeX - a high quality open-source typesetting software. LaTeX is most commonly used for medium to large technical or scientific documents but can be used for almost any type of publication. The course will, therefore, enable students to type a report, article, or mathematical document.

Course Content

Introduction to TeX and LaTeX, Benefits and comparison with word processor, Installing LaTeX, Formatting lines and paragraph, Typesetting a simple document, Text alignment, installing packages

Creating Lists, Typing Math Formulas, Environments – equations, arrays, matrices, Footnotes, Fonts, Title and Headers, Sectioning, Listing content and references, Cross- referencing, Math styles – cases, braces, minipages, math symbols, Theroem-like environments

Inserting Tables and Figures, Graphics in LaTeX, Creating pictures using PSTricks, Plotting of functions, introduction to TikZ package, Sample article and report, Preparing a large document, Beamer presentation, Sample presentation, Using online resources

Textbooks

1. David F. Griffiths, Desmond J. Higham, Learning LaTeX, Society for Industrial and Applied Mathematics(SIAM), 2016.
2. Stefan Kottwitz , LaTeX Beginner’s Guide. Packt Publishing, Birmingham, UK, 2011.
3. Lamport, Leslie, LaTeX: A Document Preparation System, User’s Guide and Reference Manual (2nd ed.). Addison-Wesley, 1994.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Conduct of Experiment	Attendance	Lab Record/ Quiz/ Viva-Voce	End Term Practical Exam
Weightage (%)	20	10	20	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	Mapped Program Outcomes
CO1	Typesetting journal articles, technical reports, books, and slide presentations.	PO9, PO10
CO2	Control over large documents containing sectioning, cross-references	PO7
CO3	Automatic generation of bibliographies and indexes	PO9, PO10

		Encourage critical thinking to conduct scientific investigations in a biased manner without prejudiced assumptions.	Assist students in analyzing questions, formulating hypotheses, evaluating and validating findings, and drawing logical conclusions.	Prepare students for pursuing research or careers and to design methods to conduct investigations of complex societal and environmental issues.	Continue to acquire relevant knowledge and skills to evaluate the concepts and scientific developments to take up any challenge.	Enhance knowledge mobilization through increased application of mathematics.	Able to use the advance knowledge in consultancy to solve real life problems.	Learn the subject with curiosity to understand new scientific developments.	Understand international perspective about mathematics.	Capability to use appropriate software's to solve mathematical equations.	Develop the protocols as per laboratory standards to accomplish the objectives.	Develop aptitude to formulate concepts based on fundamental axioms of mathematics.	Innovate, invent and solve complex mathematical problems using the knowledge of pure and applied mathematics.	Understand demands of the growing field of Mathematics by lifelong learning.	Develop problem-solving skills, critical thinking, and interest through assignments and project work	Prepare students for competitive examinations such as NET, GATE, and many others.
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
BSMA776A	LaTeX Lab							3		3	2			3		

1=weakly mapped

2= moderately mapped

3=strongly mapped

Programme and Course Mapping																	
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	**2**											**3**	**2**	**1**	**1**	**2**	**2**
CO2								**2**				**3**	**2**	**1**	**1**	**2**	**2**
CO3		**3**										**3**	**2**	**1**	**1**	**2**	**2**
CO4				**2**								**3**	**2**	**1**	**1**	**2**	**2**
CO5			**3**									**3**	**2**	**1**	**1**	**2**	**2**
CO6										**3**		**3**	**2**	**1**	**1**	**2**	**2**
1=lightly mapped 2= moderately mapped 3=strongly mapped																	

Semester III

BSMA801A	ABSTRACT ALGEBRA - II	L	T	P	C
Version 1.0		4	0	0	4
Total Contact Hours	60				
Pre-requisites/Exposure	Modern Algebra course at undergraduate level				
Co-requisites	--				

Course Objectives

1. To develop ability to deal with module theory which is used in topology and operator theory
2. To apply insights from linear algebra to other some other concept in algebra

Course Outcomes

On completion of this course, the students will be able to

CO1. Apply theory of modules similar to linear spaces over rings
C02. Apply module theory over different ideals and its applications in canonical forms
CO3. Handle complicated linear systems by decomposing them in Jordan and Ration forms
CO4. Build foundations for various research areas in pure mathematics

Catalog Description

The course aims to describe the structure of modules over Euclidean domains. This module theory is then applied to obtain the structure of abelian groups and the rational canonical and Jordan normal forms of matrices. Some fundamental concepts about modules and rings are supposed to be discussed in detail, so that some further topics like representations of groups can be easily understood.

Course Content

Unit I: **14 lecture hours**

Module Theory

Modules, General properties of modules, sub modules, Quotient modules, Homomorphism of modules, simple and semi- simple modules, free modules, Cyclic modules, Schur's lemma, Free modules, Fundamental structure theorem of finitely generated modules over principal ideal domain and its applications to finitely generated abelian groups.

Unit II: **14 lecture hours**

Neotherian and Artinian rings

Neotherian and Artinian modules and rings with simple properties and examples, Nil and Nilpotent ideals in Neotherian and Artinian rings, Hilbert Basis theorem.

Unit III: **16 lecture hours**

Uniform Modules

HomR(R,R), Opposite rings, Wedderburn – Artin theorem, Maschk's theorem, Equivalent statement for left Artinian rings having non-zero nilpotent ideals, Uniform modules, Primary modules and Neother- Lasker theorem.

Unit IV: **16 lecture hours**

Primary Decomposition Theorem

Canonical forms: Similarity of linear transformations, Invariant subspaces, Reduction to triangular form, Nilpotent transformations, Index of nilpotency, Invariants of nilpotent transformations, The primary decomposition theorem, Rational canonical forms, Jordan blocks and Jordan forms.

Textbooks

1. P.B. Bhattacharya, S.K. Jain and S.R. Nagpaul; Basic Abstract Algebra, Cambridge University Press, Indian Edition.
2. M. Artin; Algebra, Prentice-Hall of India.

Reference Books/Materials

1. P.M. Cohn; Algebra, Vols. I, II & III, John Wiley & Sons.
2. I.S. Luther and I. B. S. Passi; Algebra, Vol. I-Groups, Vol. II-Rings, NarosaPublishing House.
3. K.B. Datta; Matrix and Linear Algebra, Prentice Hall of India Pvt., New Delhi.
4. Vivek Sahai and VikasBist; Algebra, Narosa Publishing House.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	10	10	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Apply theory of modules similar to linear spaces over rings	**PO2**
CO2	Apply module theory over different ideals and its applications in canonical forms	**PO5**
CO3	Handle complicated linear systems by decomposing them in Jordan and Ration forms	**PO10**
CO4	Build foundations for various research areas in pure mathematics	**PO3**

		Encourage critical thinking to conduct scientific investigations in a biased manner without prejudiced assumptions.	Assist students in analyzing questions, formulating hypotheses, evaluating and validating findings, and drawing logical conclusions.	Prepare students for pursuing research or careers and to design methods to conduct investigations of complex societal and environmental issues.	Continue to acquire relevant knowledge and skills to evaluate the concepts and scientific developments to take up any challenge.	Enhance knowledge mobilization through increased application of mathematics.	Able to use the advance knowledge in consultancy to solve real life problems.	Learn the subject with curiosity to understand new scientific developments.	Understand international perspective about mathematics.	Capability to use appropriate software's to solve mathematical equations.	Develop the protocols as per laboratory standards to accomplish the objectives.	Develop aptitude to formulate concepts based on fundamental axioms of mathematics.	Innovate, invent and solve complex mathematical problems using the knowledge of pure and applied mathematics.	Understand demands of the growing field of Mathematics by lifelong learning.	Develop problem-solving skills, critical thinking, and interest through assignments and project work	Prepare students for competitive examinations such as NET, GATE, and many others.
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
BSMA 801A	Abstract Algebra - II			2	3			3	3				3		2	

1=weakly mapped

2= moderately mapped

3=strongly mapped

Programme and Course Mapping																	
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	**2**											**3**	**2**	**1**	**1**	**2**	**2**
CO2								**2**				**3**	**2**	**1**	**1**	**2**	**2**
CO3		**3**										**3**	**2**	**1**	**1**	**2**	**2**
CO4				**2**								**3**	**2**	**1**	**1**	**2**	**2**
CO5			**3**									**3**	**2**	**1**	**1**	**2**	**2**
CO6	**3**											**3**	**2**	**1**	**1**	**2**	**2**
1=lightly mapped 2= moderately mapped 3=strongly mapped																	

BSMA803A	MEASURE AND INTEGRATION	L	T	P	C
Version 2.0		4	0	0	4
Total Contact Hours	60				
Pre-requisites/Exposure	Real Analysis course at undergraduate level				
Co-requisites	--				

Course Objectives

1. To understand scope and limitations of Riemann integration
2. To learn of the construction of measures and integrals
3. To learn key concepts on measurable functions and their properties

Course Outcomes

On completion of this course, the students will be able to

CO1. Construct Borel sets, measurable and non-measurable sets and different type of measure

C02. Understand concept of integral, integrable functions, monotone and the dominated convergence theorem.

CO3. Apply some fundamental concepts that are particularly related to probability theory

CO4. Use measure theory in mathematics and some other fields.

Catalog Description

This course particularly attempts to give an introduction to measure and integration, and shall lay a foundation for a more advanced course on measure theory. The course begins with a review, scope and limitations of Riemann integration and moves forward with definitions and examples of Borel set, outer measure, Lebesgue measure and probability space. Measurable functions and their properties are the key concepts in this learning programme. Moreover, the concept of integral, integrable functions, monotone and the dominated convergence theorem and their applications are also considered in the plan of action.

Course Content

Unit I: 14 lecture hours

Introduction to semi-algebras

Semi-algebras, algebras, monotone class, sigma-algebras, measure and outer measure

Unit II: **16 lecture hours**

Lebesgue Measure

Borel sets, Lebesgue outer measure and Lebesgue measure on R, translation invariance of Lebesgue measure, existence of a non-measurable set, characterizations of Lebesgue measurable sets

Unit III: **16 lecture hours**

Measurable Functions

Measurable functions on a measure space and their properties. Lebesgue integral and it's properties, Comparison between Lebesgue and Riemann integral.

Unit IV: **14 lecture hours**

Convergence of Measurable Functions

Theorems on convergence of sequences of measurable functions, Bounded convergence theorem, Fatou's lemma, Lebesgue monotone convergence theorem, Lebesgue dominated convergence theorem. F-Riesz and D.F.Egorff theorem.

Textbooks

1. H. L. Royden and P. M. Fitzpatrick, Real Analysis, (Fourth edition), P.H.l. New Delhi.

Reference Books/Materials

1. P. R. Halmos; Measure Theory, Granduate Texts in Mathematics, Springer-Verlag New York, 1950.
2. I. K. Rana; An Introduction to Measure and Integration, Narosa Publishing House, New Delhi.
3. E. Hewit and K. Stromberg; Real and Abstract Analysis, Springer-Verlag Berlin Heidelberg, 1965.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Construct Borel sets, measurable and non-measurable sets and different type of measure	**PO2**
CO2	Understand concept of integral, integrable functions, monotone and the dominated convergence theorem.	**PO3**
CO3	Apply some fundamental concepts that are particularly related to probability theory	**PO7**
CO4	Use measure theory in mathematics and some other fields.	**P10**

		Encourage critical thinking to conduct scientific investigations in a biased manner without prejudiced assumptions.	Assist students in analyzing questions, formulating hypotheses, evaluating and validating findings, and drawing logical conclusions.	Prepare students for pursuing research or careers and to design methods to conduct investigations of complex societal and environmental issues.	Continue to acquire relevant knowledge and skills to evaluate the concepts and scientific developments to take up any challenge.	Enhance knowledge mobilization through increased application of mathematics.	Able to use the advance knowledge in consultancy to solve real life problems.	Learn the subject with curiosity to understand new scientific developments.	Understand international perspective about mathematics.	Capability to use appropriate software's to solve mathematical equations.	Develop the protocols as per laboratory standards to accomplish the objectives.	Develop aptitude to formulate concepts based on fundamental axioms of mathematics.	Innovate, invent and solve complex mathematical problems using the knowledge of pure and applied mathematics.	Understand demands of the growing field of Mathematics by lifelong learning.	Develop problem-solving skills, critical thinking, and interest through assignments and project work	Prepare students for competitive examinations such as NET, GATE, and many others.
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
BSMA803A	Measure and Integration		3	3				3	2				3		2	

1=weakly mapped

2= moderately mapped

3=strongly mapped

Programme and Course Mapping																	
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	**2**											**3**	**2**	**1**	**1**	**2**	**2**
CO2								**2**				**3**	**2**	**1**	**1**	**2**	**2**
CO3		**3**										**3**	**2**	**1**	**1**	**2**	**2**
CO4				**2**								**3**	**2**	**1**	**1**	**2**	**2**
CO5			**3**									**3**	**2**	**1**	**1**	**2**	**2**
CO6	**3**											**3**	**2**	**1**	**1**	**2**	**2**
1=lightly mapped 2= moderately mapped 3=strongly mapped																	

BSMA805A	ADVANCED PARTIAL DIFFERENTIAL EQUATIONS	L	T	P	C
Version 1.0		4	0	0	4
Total Contact Hours	60				
Pre-requisites/Exposure					
Co-requisites	--				

Course Objectives

1. Determine the method of characteristics to solve first order partial differential equations.
2. Classify a second order PDE as elliptic, parabolic or hyperbolic.
3. Use the method of Lagrange-Green's identity and uniqueness by energy methods.
4. Determined the representation formulas for the solutions of Laplace equation, heat equation and wave equation.
5. Understand the existence of weak solutions and shocks also similarity solutions and their applications in social sciences, physical sciences, life sciences and a host of other disciplines.

Course Outcomes

On completion of this course, the students will be able to

1. Applied the knowledge and understanding partial differential equations and how they relate to different modelling situations.
2. Applied the concept of the symbol of a PDEs and the resulting classification of PDEs.
3. Appreciate a brief knowledge of linear ODEs and PDEs with the use of the Green's function method.
4. Recognize and determined Apply the existence of weak solutions and shocks by applying mathematical modelling and reasoning to solve basic problems.
5. Determine the concept of advanced PDEs to design complex and critical financial models for any organization.
6. Apply the methods of classification of PDEs to compose the relationship of basic mathematics in real life.

Catalog Description

The focus of the course is the concepts and techniques for solving the partial differential equations (PDE) that permeate various scientific disciplines. The emphasis is on nonlinear PDE. Applications include problems from fluid dynamics, electrical and mechanical engineering, materials science, quantum mechanics, etc. Important objectives of the advanced partial differential equations are to develop and strengthen the students' problem-solving skills and to teach them to read, write, speak, and think in the language of mathematics. Students learn how to apply the tools of calculus to a variety of problem situations.

Course Content

Unit I: **14 lecture hours**

Classifications of PDE: Cauchy Problems for First Order Hyperbolic Equations: method of characteristics, Monge cone. Classification of Second Order Partial Differential Equations: normal forms and characteristics.

Unit II: **16 lecture hours**

Initial and Boundary Value Problems: Lagrange-Green's identity and uniqueness by energy methods.Stability theory, energy conservation and dispersion.

Unit III: **16 lecture hours**

Laplace equation: mean value property, weak and strong maximum principle, Green's function, Poisson's formula, Dirichlet's principle, existence of solution using Perron's method (without proof). Heat equation: initial value problem, fundamental solution, weak and strong maximum principle and uniqueness results.

Unit IV: **14 lecture hours**

Wave equation: uniqueness, D'Alembert's method, method of spherical means and Duhamel's principle. Methods of separation of variables for heat, Laplace and wave equations.

Textbooks

1. E. Di Benedetto; Partial Differential Equations, Birkhauser, Boston.
2. L.C. Evans; Partial Differential Equations, Graduate Studies in Mathematics, Vol. 19, AMS, Providence.

Reference Books/Materials

1. F. John; Partial Differential Equations, 3rd ed., Narosa Publ. Co., New Delhi.
2. E. Zauderer; Partial Differential Equations of Applied Mathematics, 2nd ed., John Wiley and Sons, New York.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	10	10	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Applied the knowledge and understanding partial differential equations and how they relate to different modelling situations.	**PO1**
CO2	Applied the concept of the symbol of a PDEs and the resulting classification of PDEs.	**PO8**
CO3	Appreciate a brief knowledge of linear ODEs and PDEs with the use of the Green's function method.	**PO2**
CO4	Recognize and determined Apply the existence of weak solutions and shocks by applying mathematical modelling and reasoning to solve basic problems.	**PO4**
CO5	Determine the concept of advanced PDEs to design complex and critical financial models for any organization.	**PO3**
CO6	Apply the methods of classification of PDEs to compose the relationship of basic mathematics in real life.	**PO1**

		Encourage critical thinking to conduct scientific investigations in a biased manner without prejudiced assumptions.	Assist students in analyzing questions, formulating hypotheses, evaluating and validating findings, and drawing logical conclusions.	Prepare students for pursuing research or careers and to design methods to conduct investigations of complex societal and environmental issues.	Continue to acquire relevant knowledge and skills to evaluate the concepts and scientific developments to take up any challenge.	Enhance knowledge mobilization through increased application of mathematics.	Able to use the advance knowledge in consultancy to solve real life problems.	Learn the subject with curiosity to understand new scientific developments.	Understand international perspective about mathematics.	Capability to use appropriate software's to solve mathematical equations.	Develop the protocols as per laboratory standards to accomplish the objectives.	Develop aptitude to formulate concepts based on fundamental axioms of mathematics.	Innovate, invent and solve complex mathematical problems using the knowledge of pure and applied mathematics.	Understand demands of the growing field of Mathematics by lifelong learning.	Develop problem-solving skills, critical thinking, and interest through assignments and project work.	Prepare students for competitive examinations such as NET, GATE, and many others.
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
BSMA 805A	Advanced Partial Differential Equations	2	3	3	2				2			3		3	2	

1=weakly mapped

2= moderately mapped

3=strongly mapped

Programme and Course Mapping																	
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	**2**											**3**	**2**	**1**	**1**	**2**	**2**
CO2								**2**				**3**	**2**	**1**	**1**	**2**	**2**
CO3		**3**										**3**	**2**	**1**	**1**	**2**	**2**
CO4				**2**								**3**	**2**	**1**	**1**	**2**	**2**
CO5						**3**						**3**	**2**	**1**	**1**	**2**	**2**
CO6	**3**											**3**	**2**	**1**	**1**	**2**	**2**
1=lightly mapped 2= moderately mapped 3=strongly mapped																	

BSMA821A	MATHEMATICAL MODELLING	L	T	P	C
Version 2.0		4	0	0	4
Total Contact Hours	60				
Pre-requisites/Exposure	Calculus and Differential Equations				
Co-requisites	--				

Course Objectives

1 To demonstrate the ability to create mathematical models of empirical or theoretical phenomena in domains such as the physical, natural, or social science.
2 To create variables and other abstractions to solve mathematical problems in conjunction with previously learned fundamental mathematical skills.
3 To draw inferences from models using mathematical techniques including problem solving, quantitative reasoning, and exploration using multiple representations such as equations, tables, and graphs.
4 To make predictions of the behaviour of this system based on the analysis of its mathematical model and take an analytical approach to problems in their future endeavours.

Course Outcomes

On completion of this course, the students will be able to

CO1 understand powerful mathematical tools such as calculus of several variables, differential equations and elementary dynamical systems theory.
CO2 apply these tools to mathematically analyze and solve contemporary problems of both theoretical and practical importance.
CO3 assemble a mathematical model for a range of physical situations and able to identify, formulate, and solve engineering problems.
CO4 critically analyse the effectiveness of any differential equation in modelling specified situations recognising that useful qualitative information in the behaviour of a system can often be gleaned from suitably "crude" models.
CO5 recognition of the need for, and an ability to engage in life-long learning.
CO6 understand the balance between the complexity / accuracy of the mathematical / statistical models used and the timeliness of the delivery of the solution.

Catalog Description

The course also provides introduction to state-of-the-art mathematical resources for mathematical modelling, optimization, numerical simulation, graph theory and forecasting techniques. Case studies will form a large part of the course. In addition to learning the mathematics behind the modelling tools, the course aims to equip students with the modelling skills and presentation skills for dealing with real world problems.

Course Content

UNIT-I **14 lecture hours**

Modelling through ODE of First order

Need, Techniques, Classifications, Characteristic and Limitations of Mathematical Models.
Modelling through Ordinary Differential Equation of First Order and systems of Ordinary Differential Equation of First Order: Linear and Non – Linear Growth and Decay Models, Compartment Models.

UNIT-II **16 lecture hours**

Modelling through Difference Equation

Modelling through Ordinary Differential Equation of Second Order: Planetary Motion, Motion of Satellites, Electrical Circuits.
Modelling through Difference Equations: Basic Theory of Linear Difference equations with constant coefficient, Models used in Economics and Finance, Population dynamics and genetics.

UNIT-III **16 lecture hours**

Modelling through Graphs

Modelling through Graphs: Directed and Signed graphs, Weighted Di-graphs, Eulerian and Hamiltonian graphs, Applications to route problems, network flow and scheduling problems.

UNIT-IV **14 lecture hours**

Simulation Modelling

Monte Carlo Simulation Modelling: simulating deterministic behaviour (area under a curve, volume under a surface). Forecasting: Time Series, Linear and Nonlinear Trend, seasonal Variations and Irregular Variations and their Measurements, Moving Averages, Single and Double exponential smoothing.

Reference Books/Materials

1. Reinhard Illner; *Mathematical Modelling*, A Case Studies Approach, Indian Editions of AMS (American Mathematical Society).
2. Rutherford Aris; *Mathematical Modelling Techniques*, Dover Publications Inc.
3. Frank R. Giordano , William P. Fox , Steven B. Horton; *A First Course in Mathematical Modeling*, Brooks Pub Co.
4. Edward A. Bender; *An Introduction to Mathematical Modeling*, John Wiley & Sons.
5. Mark M. Meerschaert; *Mathematical Modeling*, Academic Press Inc.
6. J. Caldwell and Y. M. Ram; *Mathematical Modelling*; Concepts and Case Studies, Springer.
7. S.C. Gupta and V.K. Kapoor, *Fundamentals of Applied Statistics*, Sultan Chand & Sons.
8. J. N. Kapur; *Mathematical Modelling*, New Age International Publishers.
9. John E. Hanke, Dean Wichern and Arthur G. Reitch, *Business Forecasting*, 7th Ed., Pearson.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	10	10	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Understand powerful mathematical tools such as calculus of several variables, differential equations and elementary dynamical systems theory.	**PO5**
CO2	Apply these tools to mathematically analyze and solve contemporary problems of both theoretical and practical importance.	**PO2**
CO3	Assemble a mathematical model for a range of physical situations and able to identify, formulate, and solve engineering problems.	**PO8**
CO4	Critically analyse the effectiveness of any differential equation in modelling specified situations recognising that useful qualitative information in the behaviour of a system can often be gleaned from suitably "crude" models.	**PO1**
CO5	Recognition of the need for, and an ability to engage in life-long learning.	**PO4**
CO6	Understand the balance between the complexity / accuracy of the mathematical / statistical models used and the timeliness of the delivery of the solution.	**PO6**

		Encourage critical thinking to conduct scientific investigations in a biased manner without prejudiced assumptions.	Assist students in analyzing questions, formulating hypotheses, evaluating and validating findings, and drawing logical conclusions.	Prepare students for pursuing research or careers and to design methods to conduct investigations of complex societal and environmental issues.	Continue to acquire relevant knowledge and skills to evaluate the concepts and scientific developments to take up any challenge.	Enhance knowledge mobilization through increased application of mathematics.	Able to use the advance knowledge in consultancy to solve real life problems.	Learn the subject with curiosity to understand new scientific developments.	Understand international perspective about mathematics.	Capability to use appropriate software's to solve mathematical equations.	Develop the protocols as per laboratory standards to accomplish the objectives.	Develop aptitude to formulate concepts based on fundamental axioms of mathematics.	Innovate, invent and solve complex mathematical problems using the knowledge of pure and applied mathematics.	Understand demands of the growing field of Mathematics by lifelong learning.	Develop problem-solving skills, critical thinking, and interest through assignments and project work	Prepare students for competitive examinations such as NET, GATE, and many others.
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
BSMA821A	Mathematical Modelling	3	3		2	2	3		2				3	3	3	

1=weakly mapped
2= moderately mapped
3=strongly mapped

Programme and Course Mapping																	
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	**2**											**3**	**2**	**1**	**1**	**2**	**2**
CO2								**2**				**3**	**2**	**1**	**1**	**2**	**2**
CO3		**3**										**3**	**2**	**1**	**1**	**2**	**2**
CO4				**2**								**3**	**2**	**1**	**1**	**2**	**2**
CO5			**3**									**3**	**2**	**1**	**1**	**2**	**2**
CO6	**3**											**3**	**2**	**1**	**1**	**2**	**2**
1=lightly mapped 2= moderately mapped 3=strongly mapped																	

BSMA871A	MATHEMATICAL MODELLING LAB	L	T	P	C
Version 1.0		0	0	2	1
Total Contact Hours	15				
Pre-requisites/Exposure					
Co-requisites	MATLAB / MATHEMATICA / MAPLE SOFTWARE				

Course Objectives

1 To introduce students to the elements of the mathematical modelling process.
2 To present application-driven mathematics motivated by problems from within and outside mathematics.
3 To exemplify the value of mathematics in problem solving.
4 To demonstrate connections among different mathematical topics.

Course Outcomes

On completion of this course, the students will be able to know

CO1 Able to design and conduct experiments, as well as to analyze and interpret data.
CO2 Recognize the power of mathematical modelling and analysis and be able to apply their understanding to their further studies.
CO3 Apply analytical techniques to solve a mathematical model, i.e. perform the calculations needed to obtain a solution or a suitable approximation.
CO4 An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
CO5 Suggest modifications that may improve the theoretical "fit" to the actual application being modelled being mindful of any added complexity to the efficacy of then being able to generate a feasible solution.
CO6 Bring together and flexibly apply knowledge to characterize, analyze and solve a wide range of problems.

Catalog Description

This course presents mathematical techniques for constructing quantitative mathematical models to describe different systems and predict future events. The course covers the fundamentals of deterministic models in both discrete and continuous time domain. The emphasis is on developing linear and non-linear models with sufficient amount of theoretical framework. The relevant concepts and solution methods of various difference and differential equations are discussed with graphical solution for clear analysis of nature of models.

Students who successfully complete a course in mathematical modeling should be able to: translate everyday situations into mathematical statements (models) which can be solved/analyzed, validated, and interpreted in context; identify assumptions which are consistent with the context of the problem and which in turn shape and define the mathematical

characterization of the problem; revise and improve mathematical models so that they will better correspond to empirical information and/or will support more realistic assumptions; assess the validity and accuracy of their approach relative to what the problem requires; work as members of a team toward a common goal, and communicate mathematics in both oral and written form to a broad mathematical and lay audience, including the "end users" of a modeling problem, who may be utterly unfamiliar with the mathematics used.

Course Content

Modeling of the following problems using Matlab / Mathematica / Maple etc.

List of Practicals

1. Plotting of second & third order solution family of differential equations.
2. Growth & Decay model (exponential case only).
3. Lake pollution model (with constant/seasonal flow and pollution concentration)
4. Case of single cold pill and a course of cold pills.
5. Limited growth of population (with and without harvesting).
6. Predatory-prey model (basic volterra model, with density dependence, effect of DDT, two prey one predator).
7. Epidemic model of influenza (basic epidemic model, contagious for life, disease with carriers).
8. Battle model (basic battle model, jungle warfare, long range weapons).
9. Sketching the Phase Plane for the system
10. Coupled Mass-Spring Systems
11. Second Order RLC electrical circuits
12. Shortest Path Graph Algorithms (Dijkstra's/ Floyd Warshall's/ Bellman Ford's).
13. Minimum Spanning Tree Algorithms (Kruskal's/Prim's).
14. Traffic Flow Analysis Model.
15. Fitting of trend by Moving Average Method
16. Forecasting by exponential smoothing

Reference Books/Materials

1. J. Sinha Roy and S Padhy: A course of Ordinary and Partial differential equation Kalyani Publishers,New Delhi.
2. Belinda Barnes and Glenn R. Fulford, Mathematical Modeling with Case Studies, A Differential Equation Approach using Maple and Matlab,2ndEd.,Taylor and Francis group, London and New York,2009.
3. Simmons G F, Differential equation, Tata Mc GrawHill, 1991.
4. Martin Braun, Differential Equations and their Applications, Springer International, Student Ed.
5. S. L. Ross, Differential Equations, 3rd Edition, John Wiley and Sons, India. 4. C.Y. Lin, Theory and Examples of Ordinary Differential Equations, World Scientific, 2011.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Conduct of Experiment	Attendance	Lab Record/ Quiz/ Viva-Voce	End Term Practical Exam
Weightage (%)	20	10	20	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Able to design and conduct experiments, as well as to analyze and interpret data.	**PO4**
CO2	Recognize the power of mathematical modelling and analysis and be able to apply their understanding to their further studies.	**PO7**
CO3	Apply analytical techniques to solve a mathematical model, i.e. perform the calculations needed to obtain a solution or a suitable approximation.	**PO9**
CO4	An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.	**PO3**
CO5	Suggest modifications that may improve the theoretical "fit" to the actual application being modelled being mindful of any added complexity to the efficacy of then being able to generate a feasible solution.	**PO8**
CO6	Bring together and flexibly apply knowledge to characterize, analyze and solve a wide range of problems.	**PO10**

		Encourage critical thinking to conduct scientific investigations in a biased manner without prejudiced assumptions.	Assist students in analyzing questions, formulating hypotheses, evaluating and validating findings, and drawing logical conclusions.	Prepare students for pursuing research or careers and to design methods to conduct investigations of complex societal and environmental issues.	Continue to acquire relevant knowledge and skills to evaluate the concepts and scientific developments to take up any challenge.	Enhance knowledge mobilization through increased application of mathematics.	Able to use the advance knowledge in consultancy to solve real life problems.	Learn the subject with curiosity to understand new scientific developments.	Understand international perspective about mathematics.	Capability to use appropriate software's to solve mathematical equations.	Develop the protocols as per laboratory standards to accomplish the objectives.	Develop aptitude to formulate concepts based on fundamental axioms of mathematics.	Innovate, invent and solve complex mathematical problems using the knowledge of pure and applied mathematics.	Understand demands of the growing field of Mathematics by lifelong learning.	Develop problem-solving skills, critical thinking, and interest through assignments and project work	Prepare students for competitive examinations such as NET, GATE, and many others.
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
BSMA871A	Mathematical Modelling Lab			3	2			2	2	3	3		3	3	3	

1=weakly mapped

2= moderately mapped

3=strongly mapped

Programme and Course Mapping																	
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	**2**											**3**	**2**	**1**	**1**	**2**	**2**
CO2								**2**				**3**	**2**	**1**	**1**	**2**	**2**
CO3		**3**										**3**	**2**	**1**	**1**	**2**	**2**
CO4				**2**								**3**	**2**	**1**	**1**	**2**	**2**
CO5			**3**									**3**	**2**	**1**	**1**	**2**	**2**
CO6	**3**											**3**	**2**	**1**	**1**	**2**	**2**
1=lightly mapped 2= moderately mapped 3=strongly mapped																	

BSMA823A	OPERATIONAL RESEARCH	L	T	P	C
Version 1.0		4	0	0	4
Total Contact Hours	60				
Pre-requisites/Exposure					
Co-requisites	--				

Course Objectives

1. Describe the linear programming duality. and the simplex and revised simplex algorithms
2. Describe the linear programming applications and formulations
3. Describe the transportation problem and its application
4. Describe the Assignment problem and its application
5. To acquaint the students with the use of quantitative models in decision making and game theory

Course Outcomes

On completion of this course, the students will be able to

CO1- Understand the origin and development of Operations Research
CO2- Analyze the real life systems with limited constraints
CO3-Identify a problem in your locality, formulate it as an LPP and solve
CO4- Maximize the profit, minimize the cost, minimize the time in transportation problem
CO5- Travelling salesman problem, Assignment problem
CO6 The students will be able to recognize strategic environments and to use Game Theory.

Catalogue Description

This course covers some core areas of Operational Research, namely Linear programming,, Transportation problem, Assignment problem and Game Theory. Emphasis will be placed both on the mathematical techniques and on problem formulation through examples from applications.

Course Content

Unit I: 14 lecture hours

Linear Programming Problems

Operations Research: Origin, definition, methodology and scope. Linear Programming: Formulation and solution of linear programming problems by graphical and simplex methods, Big - M and two phase methods, Degeneracy, Duality in linear programming

Unit II: **16 lecture hours**

Trasportation Problems

Transportation Problems: Basic feasible solutions, optimum solution by stepping stone and modified distribution methods, unbalanced and degenerate problems, transshipment problem. Assignment problems: Solution by Hungarian method, unbalanced problem, case of maximization, travelling salesman and crew assignment problems.

Unit III: **16 lecture hours**

Game Theory

Game Theory : Two person zero sum game, Game with saddle points, the rule of dominance; Algebraic, graphical and linear programming methods for solving mixed strategy games

Unit IV: **14 lecture hours**

Sequencing Problems

Sequencing problems: Processing of n jobs through 2 machines, n jobs through 3 machines, 2 jobs through m machines, n jobs through m machines.

Textbooks

Kanti Swarup, P.K. Gupta and Manmohan, Operations Research, Sultan Chand & Sonsv

Reference Books/Materials

1. H.A. Taha, Operation Research-An introducton, Printice Hall of India.
2. P.K. Gupta and D.S. Hira, Operations Research, S. Chand & Co.
3. S.D. Sharma, Operation Research, Kedar Nath Ram Nath Publicationsv

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	10	10	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Understand the origin and development of Operations Research	**PO7**
CO2	Analyze the real-life systems with limited constraints	**PO2**
CO3	Identify a problem in your locality, formulate it as an LPP and solve	**PO3**
CO4	Maximize the profit, minimize the cost, minimize the time in transportation problem	**PO3**
CO5	Travelling salesman problem, Assignment problem to solve real life problem	**PO6**
CO6	The students will be able to recognize strategic environments and to use Game Theory	**PO5**

		Encourage critical thinking to conduct scientific investigations in a biased manner without prejudiced assumptions	Assist students in analyzing questions, formulating hypotheses, evaluating and validating findings, and drawing logical conclusions	Prepare students for pursuing research or careers and to design methods to conduct investigations of complex societal and environmental issues. v	Continue to acquire relevant knowledge and skills to evaluate the concepts and scientific developments to take up any challenge.	Enhance knowledge mobilization through increased application of mathematics.	Able to use the advance knowledge in consultancy to solve real life problems.	Learn the subject with curiosity to understand new scientific developments.	Understand international perspective about mathematics.	Capability to use appropriate software's to solve mathematical equations.	Develop the protocols as per laboratory standards to accomplish the objectives.	Develop aptitude toformulate concepts based on fundamental axioms of mathematics	Innovate, invent and solve complex mathematical problems using the knowledge of pure and applied mathematics	Understand demands of the growing field of Mathematics by lifelong learning	Develop problem-solving skills, critical thinking, and interest through assignments and project work	Prepare students for competitive examinations such as NET, GATE, and many others.
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
BSMA823A	Operational Research		2	3		3	3	3				2	3		3	3

1=weakly mapped

2= moderately mapped

3=strongly mapped

Programme and Course Mapping																	
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	**2**											**3**	**2**	**1**	**1**	**2**	**2**
CO2								**2**				**3**	**2**	**1**	**1**	**2**	**2**
CO3		**3**										**3**	**2**	**1**	**1**	**2**	**2**
CO4				**2**								**3**	**2**	**1**	**1**	**2**	**2**
CO5			**3**									**3**	**2**	**1**	**1**	**2**	**2**
CO6	**3**											**3**	**2**	**1**	**1**	**2**	**2**
1=lightly mapped 2= moderately mapped 3=strongly mapped																	

BSMA873A	OPERATIONAL RESEARCH LAB	L	T	P	C
Version 1.0		0	0	2	1
Pre-requisites/Exposure					
Co-requisites	MATLAB				

Course Objectives

1. Understand how to find the solution of LPP having more than three variables.
2. Learn how to find IBFS of transportation problem by MATLAB.
3. Understand how to solve Assignment problem by MATLAB.

Course Outcomes

On completion of this course, the students will be able to

CO1. Solve Linear Programming Problems and its dual by MATLAB
CO2. Find Initial basic feasible solution by NWCR,LCM and VAM methods and its optimal solution by MATLAB
CO3. To understand the solution of unbalanced transportation problem and their maximisation problem by MATLAB.
CO4. Students learn how to solve Assignment problem by using MATLAB
CO5. To solve the game and optimal strategy game by MATLAB

Catalogue Description

The purpose of these labs is to help students talk and write in meaningful ways the linear programming duality and the simplex and revised simplex algorithms, transportation problem, Assignment problem, game theory. Specifically, to describe LPP clearly in terms are related to transportation ad assignment problem, and to make connections between these two.

Course Content

List of practical

- Find the Solution the LPP problem with equality constraint and mixed constraint
- To Solve the LPP problem by Big M method
- Find the Solution of the dual of LPP problem
- Solve the transportation problem by North west corner rule, LCEM and vogels method
- Check Optimality test for transportation problem by Modi method
- To obtain the solution of assignment Problem. i.e., balanced and unbalanced
- Find the saddle point and value of game

Reference Books/Materials

1. Lisa Oberbroeckling, Programming Mathematics Using MATLAB, Academic Press
2. Kanti Swarup, P.K. Gupta and Manmohan, Operations Research, Sultan Chand & Sonsv

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Conduct of Experiment	Attendance	Lab Record/ Quiz/ Viva-Voce	End Term Practical Exam
Weightage (%)	**20**	**10**	**20**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Solve Linear Programming Problems and its dual by MATLAB	**PO6, PO10**
CO2	Find Initial basic feasible solution by NWCR,LCM and VAM methods and its optimal solution by MATLAB	**PO2. PO9**
CO3	To understand the solution of unbalanced transportation problem and their maximisation problem by MATLAB.	**PO3, PO9**
CO4	Students learn how to solve Assignment problem by using MATLAB	**PO10**
CO5	To solve the game and optimal strategy game by MATLAB	**PO6, PO9**

		Encourage critical thinking to conduct scientific investigations in a biased manner without prejudiced assumptions	Assist students in analyzing questions, formulating hypotheses, evaluating and validating findings, and drawing logical conclusions	Prepare students for pursuing research or careers and to design methods to conduct investigations of complex societal and environmental issues. **v**	Continue to acquire relevant knowledge and skills to evaluate the concepts and scientific developments to take up any challenge.	Enhance knowledge mobilization through increased application of mathematics.	Able to use the advance knowledge in consultancy to solve real life problems.	Learn the subject with curiosity to understand new scientific developments.	Understand international perspective about mathematics.	Capability to use appropriate software's to solve mathematical equations.	Develop the protocols as per laboratory standards to accomplish the objectives.	Develop aptitude toformulate concepts based on fundamental axioms of mathematics	Innovate, invent and solve complex mathematical problems using the knowledge of pure and applied mathematics	Understand demands of the growing field of Mathematics by lifelong learning	Develop problem-solving skills, critical thinking, and interest through assignments and project work	Prepare students for competitive examinations such as NET, GATE, and many others.
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
BSMA 873A	Operational Research Lab		2	2			2			3	3		3	2		

1=weakly mapped
2= moderately mapped
3=strongly mapped

Programme and Course Mapping																	
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	**2**											**3**	**2**	**1**	**1**	**2**	**2**
CO2								**2**				**3**	**2**	**1**	**1**	**2**	**2**
CO3		**3**										**3**	**2**	**1**	**1**	**2**	**2**
CO4				**2**								**3**	**2**	**1**	**1**	**2**	**2**
CO5			**3**									**3**	**2**	**1**	**1**	**2**	**2**
CO6	**3**											**3**	**2**	**1**	**1**	**2**	**2**
1=lightly mapped 2= moderately mapped 3=strongly mapped																	

BSMA825A	BASICS OF STATISTICAL INFERENCE	L	T	P	C
Version 1.0		4	0	0	4
Total Contact Hours	60				
Pre-requisites/Exposure	Probability				
Co-requisites	--				

Course Objectives

1 To understand the concept of small sample and large sample tests.
2 To understand the concept of Testing of hypothesis and estimation theory.
3 To analyse and interpret the data vis-à-vis statistical inference.
4 To work on several standard examples to help them understand the various inherent concepts

Course Outcomes

On completion of this course, the students will be able to

CO1 understand of Parametric models for developing relevant inferences on associated parameters
CO2 use different nonparametric/distribution-free tests when data don't meet the assumptions of parametric test,
CO3 know advanced level topics in statistical inference on testing of statistical hypotheses for both randomized and non-randomized tests
CO4 knowledge of point and interval estimation procedures and different methods of point estimation
CO5 use appropriate experimental designs to analyze the experimental data
CO6 real lifetime data implementation of various concepts as outlined above through practical assignments.

Catalogue Description

At the end of the course, students shall be able to analyze data using various parametric and non-parametric tests. Also, the students will be in a position to visualize the scope of experimental designs in getting valid and efficient results. As a result, they will decide to select an appropriate experimental design and analyze the same to interpret the results so obtained.

Course Content

UNIT-I **16 lecture hours**

Hypothesis Tests

Estimation of population mean, confidence intervals for the parameters of a normal distribution (one sample and two sample problems). The basic idea of significance test. Null and alternative hypothesis. Type I & Type II errors, level of significance, concept of p-value. Tests of hypotheses for the parameters of a normal distribution (one sample and two sample problems).

UNIT-II **14 lectures hours**

Goodness-Fit Tests

Categorical data: Tests of proportions, tests of association and goodness-of-fit using Chi-square test, Yates' correction.

UNIT-III **16 lecture hours**

Sign Test for Symmetry

Tests for the significance of correlation coefficient. Sign test for median, Sign test for symmetry, Wilcoxon two-sample test.

UNIT-IV **14 lecture hours**

Designs of Experiments

Analysis of variance, one-way and two-way classification. Brief exposure of three basic principles of design of experiments, treatment, plot and block. Analysis of completely randomized design, randomized complete block design. Bioassay.

Reference Books/Materials

1. Daniel, Wayne W., Bio-statistics: A Foundation for Analysis in the Health Sciences. John Wiley.
2. Goon, A.M., Gupta M.K. & Das Gupta, Fundamentals of statistics, Vol.-I & II.
3. Dass, M. N. &Giri, N. C.: Design and analysis of experiments. John Wiley.
4. Dunn, O.J Basic Statistics: A primer for the Biomedical Sciences by John Wiley.
5. Bancroft, Holdon Introduction to Bio-Statistics , P.B. Hoebar New York.
6. Goldstein, A Biostatistics-An introductory text, The Macmillion New York.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	10	10	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	understand of Parametric models for developing relevant inferences on associated parameters	**PO7**
CO2	use different nonparametric/distribution-free tests when data don't meet the assumptions of parametric test,	**PO1**
CO3	know advanced level topics in statistical inference on testing of statistical hypotheses for both randomized and non-randomized tests	**PO2**
CO4	knowledge of point and interval estimation procedures and different methods of point estimation	**PO5**
CO5	use appropriate experimental designs to analyze the experimental data	**PO3**
CO6	real lifetime data implementation of various concepts as outlined above through practical assignments.	**PO4**

		Encourage critical thinking to conduct scientific investigations in a biased manner without prejudiced assumptions.	Assist students in analyzing questions, formulating hypotheses, evaluating and validating findings, and drawing logical conclusions.	Prepare students for pursuing research or careers and to design methods to conduct investigations of complex societal and environmental issues.	Continue to acquire relevant knowledge and skills to evaluate the concepts and scientific developments to take up any challenge.	Enhance knowledge mobilization through increased application of mathematics.	Able to use the advance knowledge in consultancy to solve real life problems.	Learn the subject with curiosity to understand new scientific developments.	Understand international perspective about mathematics.	Capability to use appropriate software's to solve mathematical equations.	Develop the protocols as per laboratory standards to accomplish the objectives.	Develop aptitude to formulate concepts based on fundamental axioms of mathematics.	Innovate, invent and solve complex mathematical problems using the knowledge of pure and applied mathematics.	Understand demands of the growing field of Mathematics by lifelong learning.	Develop problem-solving skills, critical thinking, and interest through assignments and project work	Prepare students for competitive examinations such as NET, GATE, and many others.
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
BSMA825A	Basics of Statistical Inference	2	3	3	3	2		2					2	3	3	

1=weakly mapped
2= moderately mapped
3=strongly mapped

Programme and Course Mapping																	
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	**2**											**3**	**2**	**1**	**1**	**2**	**2**
CO2								**2**				**3**	**2**	**1**	**1**	**2**	**2**
CO3		**3**										**3**	**2**	**1**	**1**	**2**	**2**
CO4				**2**								**3**	**2**	**1**	**1**	**2**	**2**
CO5			**3**									**3**	**2**	**1**	**1**	**2**	**2**
CO6	**3**											**3**	**2**	**1**	**1**	**2**	**2**
1=lightly mapped 2= moderately mapped 3=strongly mapped																	

BSMA875A	BASICS OF STATISTICAL INFERENCE LAB	L	T	P	C
Version 1.0		0	0	2	1
Total Contact Hours	15				
Pre-requisites/Exposure	--				
Co-requisites	MINITAB /MATLAB/R/ SAS/ SPSS/ STATISTIKA				

Course Objectives

1 Knowledge of Statistics and its scope and importance in various areas such as Medical, Engineering, Agricultural and Social Sciences etc.
2 Knowledge of other types of data reflecting quality characteristics including concepts of independence and association between two attributes
3 Real illustrations for the concepts mentioned above through laboratory assignments

Course Outcomes

On completion of this course, the students will be able to know

CO1 with knowledge of two dimensional discrete and continuous random variables, their associated distributions and characteristics
CO2 with inferential knowledge regarding the parameters of Bivariate and Multivariate Normal distributions
CO3 confidence interval estimation and their relationships with testing
CO4 knowledge about important inferential aspects such as point estimation, test of hypotheses and associated concepts
CO5 order statistics and their distributions
CO6 give statistical interpretation of the experimental results obtained

Catalogue Description

This course is based on BSMA 825A and will provide practical knowledge to the students on various concepts elaborated in the course. R programming is introduced in this practical. All standard statistical software packages, namely, MINITAB, MATLAB, R, MATHEMATICA, SAS, S-SPLUS, STATISTIKA, etc. are introduced and also used in the subsequent practical courses and projects.

Course Content

List of Practicals

1. Estimators of population mean.
2. Confidence interval for the parameters of a normal distribution (one sample and two sample problems).
3. Tests of hypotheses for the parameters of a normal distribution (one sample and two sample problems).
4. Chi-square test of proportions.
5. Chi-square tests of association.
6. Chi-square test of goodness-of-fit.
7. Test for correlation coefficient.
8. Sign test for median.
9. Sign test for symmetry.
10. Wilcoxon two-sample test.
11. Analysis of Variance of a one way classified data
12. Analysis of Variance of a two way classified data.
13. Analysis of a CRD.
14. Analysis of an RBD.

Reference Books/Materials

1. Daniel, Wayne W., Bio-statistics: A Foundation for Analysis in the Health Sciences. John Wiley.
2. Goon, A.M., Gupta M.K. & Das Gupta, Fundamentals of statistics, Vol.-I & II.
3. Dass, M. N. &Giri, N. C.: Design and analysis of experiments. John Wiley.
4. Dunn, O.J Basic Statistics: A primer for the Biomedical Sciences by John Wiley.
5. Bancroft, Holdon Introduction to Bio-Statistics , P.B. Hoebar New York.
6. Goldstein, A Biostatistics-An introductory text, The Macmillion New York.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	**Conduct of Experiment**	**Attendance**	**Lab Record/ Quiz/ Viva-Voce**	**End Term Practical Exam**
Weightage (%)	**20**	**10**	**20**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	with knowledge of two dimensional discrete and continuous random variables, their associated distributions and characteristics	**PO9**
CO2	with inferential knowledge regarding the parameters of Bivariate and Multivariate Normal distributions	**PO2**
CO3	confidence interval estimation and their relationships with testing	**PO3**
CO4	knowledge about important inferential aspects such as point estimation, test of hypotheses and associated concepts	**PO8**
CO5	order statistics and their distributions	**PO5**
CO6	give statistical interpretation of the experimental results obtained	**PO10**

		Encourage critical thinking to conduct scientific investigations in a biased manner without prejudiced assumptions.	Assist students in analyzing questions, formulating hypotheses, evaluating and validating findings, and drawing logical conclusions.	Prepare students for pursuing research or careers and to design methods to conduct investigations of complex societal and environmental issues.	Continue to acquire relevant knowledge and skills to evaluate the concepts and scientific developments to take up any challenge.	Enhance knowledge mobilization through increased application of mathematics.	Able to use the advance knowledge in consultancy to solve real life problems.	Learn the subject with curiosity to understand new scientific developments.	Understand international perspective about mathematics.	Capability to use appropriate software's to solve mathematical equations.	Develop the protocols as per laboratory standards to accomplish the objectives.	Develop aptitude to formulate concepts based on fundamental axioms of mathematics.	Innovate, invent and solve complex mathematical problems using the knowledge of pure and applied mathematics.	Understand demands of the growing field of Mathematics by lifelong learning.	Develop problem-solving skills, critical thinking, and interest through assignments and project work	Prepare students for competitive examinations such as NET, GATE, and many others.
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
BSMA875A	Basics of Statistical Inference Lab		3	3		2			2	3	3		2	3	3	

1=weakly mapped

2= moderately mapped

3=strongly mapped

Programme and Course Mapping																	
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	**2**											**3**	**2**	**1**	**1**	**2**	**2**
CO2								**2**				**3**	**2**	**1**	**1**	**2**	**2**
CO3		**3**										**3**	**2**	**1**	**1**	**2**	**2**
CO4				**2**								**3**	**2**	**1**	**1**	**2**	**2**
CO5			**3**									**3**	**2**	**1**	**1**	**2**	**2**
CO6	**3**											**3**	**2**	**1**	**1**	**2**	**2**
1=lightly mapped 2= moderately mapped 3=strongly mapped																	

BSMA827A	STOCHASTIC PROCESSES AND QUEUING THEORY	L	T	P	C
Version 1.0		4	0	0	4
Total Contact Hours	60				
Pre-requisites/Exposure					
Co-requisites	--				

Course Objectives

1. To understand the basic notions of probability theory, give a definition of a stochastic process; plot a trajectory and find finite-dimensional distributions for simple stochastic processes.
2. To describe and explain the theory of Markov Chains
3. To understand the definitions and main properties of Poisson processes of different types and apply these processes to various real-life tasks,
4. To describe and analyze basic Markov queuing models and situations to which they may be applied
5. To describe networks of queuing systems

Course Outcomes

On completion of this course, the students will be able to

CO1- Understand the basic of Probability Distributions

CO2- To construct models in discrete and continuous time based on Markov Chains and explain the theory of Markov Chains

CO3- To analyze basic Markov queuing models which applied to describe networks of queuing systems

CO4- Determine the stationary distributions of a Markov chain

CO5- Understand strengths and weaknesses of Queuing Models

CO6 -To develop the modeling and mathematical skills to analytically determine computer systems

Catalog Description

Basic mathematical modeling is at the heart of engineering. In both electrical and computer engineering, many complex systems are modeled using stochastic processes. This course will introduce students to basic stochastic processes and queuing theory tools that can be utilized for performance analysis.

Course Content

Unit I: 14 lecture hours

Stochastic Process

Probability Distributions: Generating functions, Bivariate probability generating function. Stochastic Process: Introduction, Stationary Process.

Unit II: **16 lecture hours**

Markov Chains

Markov Chains: Definition of Markov Chain, transition probability matrix, order of Markovchain, Markov chain as graphs, higher transition probabilities. Generalization of independent Bernoulli trials, classification of states and chains, stability of Markov system, graph theoretic approach.

Unit III: **16 lecture hours**

Poisson Process

Poisson Process: postulates of Poisson process, properties of Poisson process, inter-arrival time, pure birth process, Yule Furry process, birth and death process, pure death process.

Unit IV: **14 lecture hours**

Queuing Models

Queuing System: General concept, steady state distribution, queuing model, M/M/1 with finite and infinite system capacity, waiting time distribution (without proof). Gambler's Ruin Problem: Classical ruin problem, expected duration of the game.

Reference Books/Materials

1. Medhi, J. (2009): Stochastic Processes, New Age International Publishers.
2. Basu, A.K. (2005): Introduction to Stochastic Processes, Narosa Publishing.
3. Bhat,B.R.(2000): Stochastic Models: Analysis and Applications, New Age International Publishers.
4. Taha, H. (1995): Operations Research: An Introduction, Prentice- Hall India.
5. Feller, William (1968): Introduction to probability Theory and Its Applications, Wiley International.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	10	10	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Understand the basic of Probability Distributions determine computer systems	**PO7**
CO2	To construct models in discrete and continuous time based on Markov Chains and explain the theory of Markov Chains	**PO2**
CO3	To analyze basic Markov queuing models which applied to describe networks of queuing systems	**PO3**
CO5	Understand strengths and weaknesses of Queuing Models	**PO6**
CO6	To develop the modeling and mathematical skills to analytically	**PO5**

		Encourage critical thinking to conduct scientific investigations in a biased manner without prejudiced assumptions	Assist students in analyzing questions, formulating hypotheses, evaluating and validating findings, and drawing logical conclusions	Prepare students for pursuing research or careers and to design methods to conduct investigations of complex societal and environmental issues. v	Continue to acquire relevant knowledge and skills to evaluate the concepts and scientific developments to take up any challenge.	Enhance knowledge mobilization through increased application of mathematics.	Able to use the advance knowledge in consultancy to solve real life problems.	Learn the subject with curiosity to understand new scientific developments.	Understand international perspective about mathematics.	Capability to use appropriate software's to solve mathematical equations.	Develop the protocols as per laboratory standards to accomplish the objectives.	Develop aptitude toformulate concepts based on fundamental axioms of mathematics	Innovate, invent and solve complex mathematical problems using the knowledge of pure and applied mathematics	Understand demands of the growing field of Mathematics by lifelong learning	Develop problem-solving skills, critical thinking, and interest through assignments and project work	Prepare students for competitive examinations such as NET, GATE, and many others.
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
BSMA 827 A	**Stochastic Processes and Queuing Theory**		2	3		3	3	3				2	2			3

1=weakly mapped

2= moderately mapped

3=strongly mapped

Programme and Course Mapping																	
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	**2**											**3**	**2**	**1**	**1**	**2**	**2**
CO2								**2**				**3**	**2**	**1**	**1**	**2**	**2**
CO3		**3**										**3**	**2**	**1**	**1**	**2**	**2**
CO4				**2**								**3**	**2**	**1**	**1**	**2**	**2**
CO5			**3**									**3**	**2**	**1**	**1**	**2**	**2**
CO6	**3**											**3**	**2**	**1**	**1**	**2**	**2**
1=lightly mapped 2= moderately mapped 3=strongly mapped																	

BSMA877A	STOCHASTIC PROCESSES AND QUEUING THEORY LAB	L	T	P	C
Version 1.0		0	0	2	1
Total Contact Hours	15				
Pre-requisites/Exposure					
Co-requisites	MATLAB				

Course Objectives

The purpose of these labs is to help students talk and write in meaningful ways The Poisson process, Discrete time and continuous time Markov Chains. Markov queuing systems: one server, several servers, finite and infinite carrying capacity, Markovian queuing systems, networks of queuing systems, M/M/, M/M/m, M/G/1 systems, Theory and methods applied to applications in communication, traffic and transport systems.

Course Outcomes

On completion of this course, the students will be able to

CO1.Calculation of transition probability matrix and Identification of characteristics of reducible
and irreducible chains.
CO2. Identification of types of classes and ergodic transition probability matrix
CO3. Stationary of Markov chain and graphical representation of Markov chain and Computation of probabilities in case of generalizations of independent Bernoulli trials
CO4 Calculation of probabilities for given birth and death rates and compute the inter-arrival time for a Poisson process.
CO5 Calculation of Probability and parameters for (M/M/1) model and change in behaviour of queue as N tends to infinity and compute the probabilities and expected duration between players.

Catalog Description

The aim of this course is to provide students with basic knowledge of stochastic models with a special focus on queueing models, that may apply to telecommunications topics, such as traffic modelling, performance evaluation, resource provisioning and traffic management.

List of Practicals

1. Calculation of transition probability matrix
2. Identification of characteristics of reducible and irreducible chains.
3. Identification of types of classes
4. Identification of ergodic transition probability matrix
5. Stationarity of Markov chain and graphical representation of Markov chain
6. Computation of probabilities in case of generalizations of independent Bernoulli trials
7. Calculation of probabilities for given birth and death rates and vice versa

8. Computation of inter-arrival time for a Poisson process.
9. Calculation of Probability and parameters for (M/M/1) model and change in behaviour of queue as N tends to infinity.
10. Calculation of generating function and expected duration for different amounts of stake.
11. Computation of probabilities and expected duration between players.

Reference Books/Materials

1. **Nelson**, Randolph **, Probability, Stochastic Processes, and Queueing Theory, Springer**
2. Andrey Sarantsev**, Introduction To Probability Theory And Stochastic Processes(Online)**

Components	Conduct of Experiment	Attendance	Lab Record/ Quiz/ Viva-Voce	End Term Practical Exam
Weightage (%)	**20**	**10**	**20**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Calculation of transition probability matrix and Identification of characteristics of reducible and irreducible chains.	**PO2,PO9**
CO2	Identification of types of classes and ergodic transition probability matrix	**PO7**
CO3	Stationary of Markov chain and graphical representation of Markov chain and Computation of probabilities in case of generalizations of independent Bernoulli trials	**PO3, PO10**
CO4	Calculation of probabilities for given birth and death rates and compute the inter-arrival time for a Poisson process.	**PO5, PO10**
CO5	Calculation of Probability and parameters for (M/M/1) model and change in behaviour of queue as N tends to infinity and compute the probabilities and expected duration between players.	**PO2, PO9**

		Encourage critical thinking to conduct scientific investigations in a biased manner without prejudiced assumptions	Assist students in analyzing questions, formulating hypotheses, evaluating and validating findings, and drawing logical conclusions	Prepare students for pursuing research or careers and to design methods to conduct investigations of complex societal and environmental issues. v	Continue to acquire relevant knowledge and skills to evaluate the concepts and scientific developments to take up any challenge.	Enhance knowledge mobilization through increased application of mathematics.	Able to use the advance knowledge in consultancy to solve real life problems.	Learn the subject with curiosity to understand new scientific developments.	Understand international perspective about mathematics.	Capability to use appropriate software's to solve mathematical equations.	Develop the protocols as per laboratory standards to accomplish the objectives.	Develop aptitude toformulate concepts based on fundamental axioms of mathematics	Innovate, invent and solve complex mathematical problems using the knowledge of pure and applied mathematics	Understand demands of the growing field of Mathematics by lifelong learning	Develop problem-solving skills, critical thinking, and interest through assignments and project work	Prepare students for competitive examinations such as NET, GATE, and many others.
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
BSMA 877A	Stochastic Processes and Queuing Theory Lab		3	3		2		2		3	3		3	2	3	

1=weakly mapped

2= moderately mapped

3=strongly mapped

Programme and Course Mapping																	
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	**2**											**3**	**2**	**1**	**1**	**2**	**2**
CO2								**2**				**3**	**2**	**1**	**1**	**2**	**2**
CO3		**3**										**3**	**2**	**1**	**1**	**2**	**2**
CO4				**2**								**3**	**2**	**1**	**1**	**2**	**2**
CO5			**3**									**3**	**2**	**1**	**1**	**2**	**2**
CO6	**3**											**3**	**2**	**1**	**1**	**2**	**2**
1=lightly mapped 2= moderately mapped 3=strongly mapped																	

BSCA330A	NETWORK SECURITY AND CRYPTOGRAPHY	**L**	**T**	**P**	**C**
Version 2.0		**3**	**1**	**0**	**4**
Total Contact Hours	**60**				
Pre-requisites/Exposure					
Co-requisites	**--**				

Course Objectives

1. Understand the difference between classical and modern cryptography.
2. Learn the fundamentals of cryptography, including Data and Advanced Encryption Standards (DES & AES) and RSA.
3. Encrypt and decrypt messages using block ciphers, sign and verify messages using well-known signature generation and verification algorithms.
4. Know about the aspects of number theory which are relevant to cryptography.

Course Outcomes

On completion of this course, the students will be able to

CO1. Describe network security services and mechanisms.
CO2. Differentiate between Symmetrical and Asymmetrical cryptography.
CO3. Analyze Data integrity, Authentication, Digital Signatures
CO4. Understand various network security applications, IPSec, Firewall, IDS, Web security, Email security, and malicious software etc.

Catalogue Description

Network Security and Cryptography is an indispensable tool for protecting information in computer systems. In this course students will learn the inner workings of cryptographic systems and how to correctly use them in real-world applications. The course begins with a detailed discussion of how two parties who have a shared secret key can communicate securely when a powerful adversary eavesdrops and tampers with traffic. Students will examine many deployed protocols and analyze mistakes in existing systems. The second half of the course discusses public-key techniques that let two parties generate a shared secret key. Throughout the course participants will be exposed to many exciting open problems in the field and work on fun (optional) programming projects. In a second course (Crypto II) we will cover more advanced cryptographic tasks such as zero-knowledge, privacy mechanisms, and other forms of encryption.

Course Content

Unit I: 14 lecture hours

Introduction: Plain text and cipher text, substitution techniques, transposition techniques, encryption and decryption, symmetric and asymmetric key cryptography.

Unit II: 16 lecture hours

Symmetric and Asymmetric key algorithms: Introduction, algorithm types and modes, DES, AES. Introduction, history of asymmetric key cryptography, RSA symmetric and asymmetric key cryptography together, Digital signature.

Unit III: 16 lecture hours

Internet security protocols: basic concepts, Secure Socket Layer (SSL), Transport Layer Security (TLS), Secure HyperText Transfer protocol (SHTTP), Time Stamping Protocol (TSP), Secure Electronic Transaction (SET), SSL versus SET, Electronic Money, Email Security.

Unit IV: 14 lecture hours

User Authentication and Kerberos: Introduction, Authentication basics, Passwords, authentication tokens, certificate based authentication, biometric based authentication, Kerberos, key distribution center (KDC), Security handshake pitfalls, single sign on(SSO) approach.

Textbooks

1. Atul Kahate, "Cryptography and Network Security", TMH
2. Mani Subramaniam , "Network Management Principles & Practices" AWL

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	10	10	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Describe network security services and mechanisms.	**PO1,PO7**
CO2	Differentiate between Symmetrical and Asymmetrical cryptography.	**PO5,PO7**
CO3	Analyze Data integrity, Authentication, Digital Signatures	**PO8,PO7**
CO4	Understand various network security applications, IPSec, Firewall, IDS, Web security, Email security, and malicious software etc.	**PO4,PO7**

		Encourage critical thinking to conduct scientific investigations in a biased manner without prejudiced assumptions.	Assist students in analyzing questions, formulating hypotheses, evaluating and validating findings, and drawing logical conclusions.	Prepare students for pursuing research or careers and to design methods to conduct investigations of complex societal and environmental issues.	Continue to acquire relevant knowledge and skills to evaluate the concepts and scientific developments to take up any challenge.	Enhance knowledge mobilization through increased application of mathematics.	Able to use the advance knowledge in consultancy to solve real life problems.	Learn the subject with curiosity to understand new scientific developments.	Understand international perspective about mathematics.	Capability to use appropriate software's to solve mathematical equations.	Develop the protocols as per laboratory standards to accomplish the objectives.	Develop aptitude to formulate concepts based on fundamental axioms of mathematics.	Innovate, invent and solve complex mathematical problems using the knowledge of pure and applied mathematics.	Understand demands of the growing field of Mathematics by lifelong learning.	Develop problem-solving skills, critical thinking, and interest through assignments and project work	Prepare students for competitive examinations such as NET, GATE, and many others.
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
BSCA330A	Network Security and Cryptography	3			3	3		3	3			2		3	3	

1=weakly mapped
2= moderately mapped
3=strongly mapped

Programme and Course Mapping																	
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	**2**											**3**	**2**	**1**	**1**	**2**	**2**
CO2								**2**				**3**	**2**	**1**	**1**	**2**	**2**
CO3		**3**										**3**	**2**	**1**	**1**	**2**	**2**
CO4				**2**								**3**	**2**	**1**	**1**	**2**	**2**
CO5			**3**									**3**	**2**	**1**	**1**	**2**	**2**
CO6	**3**											**3**	**2**	**1**	**1**	**2**	**2**
1=lightly mapped 2= moderately mapped 3=strongly mapped																	

BSCA372A	NETWORK SECURITY AND CRYPTOGRAPHY LAB	**L**	**T**	**P**	**C**
Version 1.0		**0**	**0**	**2**	**1**
Total Contact Hours	**15**				
Pre-requisites/Exposure					
Co-requisites	**--**				

Course Objectives

1. Understand the difference between classical and modern cryptography.
2. Learn the fundamentals of cryptography, including Data and Advanced Encryption Standards (DES & AES) and RSA.
3. Encrypt and decrypt messages using block ciphers, sign and verify messages using well-known signature generation and verification algorithms.
4. Know about the aspects of number theory which are relevant to cryptography.

Course Outcomes

On completion of this course, the students will be able to

CO1. Describe network security services and mechanisms.
CO2. Differentiate between Symmetrical and Asymmetrical cryptography.
CO3. Analyze Data integrity, Authentication, Digital Signatures
CO4. Understand various network security applications, IPSec, Firewall, IDS, Web security, Email security, and malicious software etc.

Catalog Description

Network Security and Cryptography is an indispensable tool for protecting information in computer systems. In this course students will learn the inner workings of cryptographic systems and how to correctly use them in real-world applications. The course begins with a detailed discussion of how two parties who have a shared secret key can communicate securely when a powerful adversary eavesdrops and tampers with traffic. Students will examine many deployed protocols and analyze mistakes in existing systems. The second half of the course discusses public-key techniques that let two parties generate a shared secret key. Throughout the course participants will be exposed to many exciting open problems in the field and work on fun (optional) programming projects. In a second course (Crypto II) we will cover more advanced cryptographic tasks such as zero-knowledge, privacy mechanisms, and other forms of encryption.

Course Content

List of Experiments

1. Understanding types of Network Attacks:
2. Case study of different types of passive and active attacks (2 each).
3. To study Symmetric key encryption principles.
4. Write a program to implement DES algorithm or use existing library programs to test it.
5. Examine different techniques for authentication. Study examples of each type.
6. Examine how PGP works.
7. Use the tools available at gnupg.org, study the commands and use it.
8. To study MD5 algorithm. Use existing implementations in your own code to generate and verify MD5 hashes for files.
9. To study RSA algorithm.
10. Study of Secure Socket Layer (SSL).
11. To study security requirements for websites
12. To study Wireless Network security.
13. Examine how firewalls work.

Textbooks

1. Jeffrey Hoffstein, Jill Pipher & Joseph H. Silverman (2014). An Introduction to Mathematical Cryptography (2nd edition). Springer.
2. Neal Koblitz (1994). A Course in Number Theory and Cryptography (2nd edition). Springer-Verlag.
3. Christof Paar & Jan Pelzl (2014). Understanding Cryptography. Springer.
4. Simon Rubinstein-Salzedo (2018). Cryptography. Springer.
5. Douglas R. Stinson & Maura B. Paterson (2019). Cryptography Theory and Practice

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Conduct of Experiment	Attendance	Lab Record /Quiz/Viva-Voce	End Term Practical Exam
Weightage (%)	20	10	20	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Describe network security services and mechanisms.	**PO2,PO7**
CO2	Differentiate between Symmetrical and Asymmetrical cryptography.	**PO5,PO7**
CO3	Analyze Data integrity, Authentication, Digital Signatures	**PO8,PO7,PO10**
CO4	Understand various network security applications, IPSec, Firewall, IDS, Web security, Email security, and malicious software etc.	**PO4,PO7,PO10**

		Encourage critical thinking to conduct scientific investigations in a biased manner without prejudiced assumptions.	Assist students in analyzing questions, formulating hypotheses, evaluating and validating findings, and drawing logical conclusions.	Prepare students for pursuing research or careers and to design methods to conduct investigations of complex societal and environmental issues.	Continue to acquire relevant knowledge and skills to evaluate the concepts and scientific developments to take up any challenge.	Enhance knowledge mobilization through increased application of mathematics.	Able to use the advance knowledge in consultancy to solve real life problems.	Learn the subject with curiosity to understand new scientific developments.	Understand international perspective about mathematics.	Capability to use appropriate software's to solve mathematical equations.	Develop the protocols as per laboratory standards to accomplish the objectives.	Develop aptitude to formulate concepts based on fundamental axioms of mathematics.	Innovate, invent and solve complex mathematical problems using the knowledge of pure and applied mathematics.	Understand demands of the growing field of Mathematics by lifelong learning.	Develop problem-solving skills, critical thinking, and interest through assignments and project work	Prepare students for competitive examinations such as NET, GATE, and many others.
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
BSCA330A	Network Security and Cryptography		2		2	2		3	3		3		3	3	3	

1=weakly mapped
2= moderately mapped
3=strongly mapped

Programme and Course Mapping																	
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	**2**											**3**	**2**	**1**	**1**	**2**	**2**
CO2								**2**				**3**	**2**	**1**	**1**	**2**	**2**
CO3		**3**										**3**	**2**	**1**	**1**	**2**	**2**
CO4				**2**								**3**	**2**	**1**	**1**	**2**	**2**
CO5			**3**									**3**	**2**	**1**	**1**	**2**	**2**
CO6	**3**											**3**	**2**	**1**	**1**	**2**	**2**
1=lightly mapped 2= moderately mapped 3=strongly mapped																	

BSCS401A	ARTIFICIAL INTELLIGENCE	L	T	P	C
Version 1.0		4	0	0	4
Total Contact Hours	60				
Pre-requisites/Exposure	Logical and Analytical skill				
Co-requisites	--				

Course Objectives

1 Become familiar with basic principles of AI toward problem solving, inference, perception, knowledge representation, and learning.
2 To understand how machines act accordingly to situations as a human brain
3 To understand different search algorithms and their implementation at realistic models.
4 Investigate applications of AI techniques in intelligent agents, expert systems, and other machine learning models

Course Outcomes

On completion of this course, the students will be able to know.

CO1 Demonstrate fundamental understanding of the history of artificial intelligence (AI) and its foundations.
CO2 Apply basic principles of AI in solutions that require problem solving, inference, perception, knowledge representation, and learning.
CO3 Demonstrate awareness and a fundamental understanding of various applications of AI techniques in intelligent agents, expert systems, and other machine learning models.
CO4 Understanding of rule based and knowledge-based approaches in real life scenarios.

CO5 Demonstrate proficiency in applying scientific method to models of machine learning.

Catalog Description

In this course, An introduction to the basic principles, techniques, and applications of Artificial Intelligence. Coverage includes knowledge representation, handling uncertainties, logic inference, problem solving, search algorithms, natural language processing, perception, learning, planning, and agent design. In addition, how artificial intelligence is used in real-world situations.

Course Content

UNIT-I **14 lecture hours**

Scope of AI: Games, theorem proving, natural language processing, vision and speech processing, robotics, expert systems, AI techniques-search knowledge, abstraction. State space search; production systems, search space control; depth-first, breadth-first search.
Heuristic search, Hill climbing, best-first search, A* Algorithm, Problem Reduction, Constraint Satisfaction

UNIT-II **16 lecture hours**

Knowledge Representation: Predicate Logic: Unification, Modus Ponens, Modus Tokens, Resolution in Predicate Logic, Conflict Resolution Forward Chaining, Backward Chaining, Declarative and Procedural Representation, Rule based Systems. Semantic Nets: Slots, exceptions and default frames, conceptual dependency.

UNIT-III **14 lecture hours**

Handling Uncertainty: Non-Monotonic Reasoning, Probabilistic reasoning: Bayesian Inference, use of uncertainty factors. Introduction to Natural Language Processing, Syntactic Processing, Semantic Processing, Pragmatic Processing.

UNIT-IV **16 lecture hours**

Learning and Expert Systems: Concept of learning, learning automation, genetic algorithm, learning by inductions, neural nets. Need and justification for expert systems, knowledge acquisition, Case Studies: MYCIN, RI.

Textbooks

1. Artificial Intelligence, E. Rich and K. Knight, TMH.

Reference Books/Materials

1. Artificial Intelligence, P. H. Winston, Pearson Education.
2. Introduction to AI and Expert Systems, D. W. Patterson, PHI.
3. Principles of AI, N. J. Nilsson, Narosa Publishing House.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	10	10	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Demonstrate fundamental understanding of the history of artificial intelligence (AI) and its foundations.	**PO7, PO8**
CO2	Apply basic principles of AI in solutions that require problem solving, inference, perception, knowledge representation, and learning.	**PSO4**
CO3	Demonstrate awareness and a fundamental understanding of various applications of AI techniques in intelligent agents, expert systems, and other machine learning models.	**PO4, PSO1**
CO4	Understanding of rule based and knowledge-based approaches in real life scenarios.	**PO6**
CO5	Demonstrate proficiency in applying scientific method to models of machine learning.	**PSO3**

		Encourage critical thinking to conduct scientific investigations in a biased manner without prejudiced assumptions.	Assist students in analyzing questions, formulating hypotheses, evaluating and validating findings, and drawing logical conclusions.	Prepare students for pursuing research or careers and to design methods to conduct investigations of complex societal and environmental issues.	Continue to acquire relevant knowledge and skills to evaluate the concepts and scientific developments to take up any challenge.	Enhance knowledge mobilization through increased application of mathematics.	Able to use the advance knowledge in consultancy to solve real life problems.	Learn the subject with curiosity to understand new scientific developments.	Understand international perspective about mathematics.	Capability to use appropriate software's to solve mathematical equations.	Develop the protocols as per laboratory standards to accomplish the objectives.	Develop aptitude to formulate concepts based on fundamental axioms of mathematics.	Innovate, invent and solve complex mathematical problems using the knowledge of pure and applied mathematics.	Understand demands of the growing field of Mathematics by lifelong learning.	Develop problem-solving skills, critical thinking, and interest through assignments and project work	Prepare students for competitive examinations such as NET, GATE, and many others.
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
BSCS401A	Artificial Intelligence				2		2	3	3			2		2	3	

1=weakly mapped
2= moderately mapped
3=strongly mapped

Programme and Course Mapping																	
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	**2**											**3**	**2**	**1**	**1**	**2**	**2**
CO2								**2**				**3**	**2**	**1**	**1**	**2**	**2**
CO3		**3**										**3**	**2**	**1**	**1**	**2**	**2**
CO4				**2**								**3**	**2**	**1**	**1**	**2**	**2**
CO5			**3**									**3**	**2**	**1**	**1**	**2**	**2**
CO6	**3**											**3**	**2**	**1**	**1**	**2**	**2**
1=lightly mapped 2= moderately mapped 3=strongly mapped																	

BSCS451A	ARTIFICIAL INTELLIGENCE LAB	L	T	P	C
Version 1.0		0	0	2	1
Total Contact Hours	15				
Pre-requisites/Exposure	Basics of Programming				
Co-requisites	--				

Course Objectives

1. The basic objective of AI (also called heuristic programming, machine intelligence) is to enable computers to perform such intellectual tasks as decision making, problem solving, perception, understanding human communication (in any language, and translate among them).
2. To understand main aim of Artificial intelligence how to automate the things as far as it can and reduce the need for manpower.

Course Outcomes

On completion of this course, the students will be able to know.

CO1	Understand how to set up an environment for working with AI problems. What are the other options/software that can be used for AI problems
CO2	How prolog can be used for inference, perception, knowledge representation, and learning processes.
CO3	How to apply rule based and knowledge-based approaches in real life scenarios by checking the working of different algorithms on prolog
CO4	Using knowledge of reasoning in the presence of incomplete and/or uncertain information

Catalog Description

While AI applications can be developed in any number of different languages, certain language features make programming AI applications straightforward. Prolog is structured in such a way that AI program development is supported by Prolog language features. Other languages, such as Java, support AI programming through code libraries. This course will provide students with an introduction to AI via programming features that support basic AI applications. It enables them to write algorithms for solving problems with the help of fundamental of artificial intelligence.

List of Experiments (Indicative)

1	Write a program to solve 8-queens problem.	**4 lab hours**
2	Solve any problem using depth first search.	**2 lab hours**
3	Solve any problem using best first search.	**2 lab hours**
4	Solve 8-puzzle problem using best first search.	**3 lab hours**
5	Solve Robot (traversal) problem using means End Analysis.	**2 lab hours**
6	Solve traveling salesman problem.	**2 lab hours**

Modes of Evaluation: Quiz/Oral practical oral exam/presentation/projects/Practical Examination

Examination Scheme:

Components	Conduct of Experiment	Attendance	Lab Record/ Quiz/ Viva-Voce	End Term Practical Exam
Weightage (%)	**20**	**10**	**20**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Understand how to set up an environment for working with AI problems. What are the other options/software that can be used for AI problems	**PO1, PO5**
CO2	How prolog can be used for inference, perception, knowledge representation, and learning processes.	**PO2, PO8, PSO4**
CO3	How to apply rule based and knowledge-based approaches in real life scenarios by checking the working of different algorithms on prolog	**PO6, PSO3**
CO4	Using knowledge of reasoning in the presence of incomplete and/or uncertain information	**PSO1, PO4**

		Encourage critical thinking to conduct scientific investigations in a biased manner without prejudiced assumptions.	Assist students in analyzing questions, formulating hypotheses, evaluating and validating findings, and drawing logical conclusions.	Prepare students for pursuing research or careers and to design methods to conduct investigations of complex societal and environmental issues.	Continue to acquire relevant knowledge and skills to evaluate the concepts and scientific developments to take up any challenge.	Enhance knowledge mobilization through increased application of mathematics.	Able to use the advance knowledge in consultancy to solve real life problems.	Learn the subject with curiosity to understand new scientific developments.	Understand international perspective about mathematics.	Capability to use appropriate software's to solve mathematical equations.	Develop the protocols as per laboratory standards to accomplish the objectives.	Develop aptitude to formulate concepts based on fundamental axioms of mathematics.	Innovate, invent and solve complex mathematical problems using the knowledge of pure and applied mathematics.	Understand demands of the growing field of Mathematics by lifelong learning.	Develop problem-solving skills, critical thinking, and interest through assignments and project work	Prepare students for competitive examinations such as NET, GATE, and many others.
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
BSCS 451A	Artificial Intelligence Lab	2	2		3	2	2		3			2		2	3	

1=weakly mapped

2= moderately mapped

3=strongly mapped

Programme and Course Mapping																	
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	**2**											**3**	**2**	**1**	**1**	**2**	**2**
CO2								**2**				**3**	**2**	**1**	**1**	**2**	**2**
CO3		**3**										**3**	**2**	**1**	**1**	**2**	**2**
CO4				**2**								**3**	**2**	**1**	**1**	**2**	**2**
CO5			**3**									**3**	**2**	**1**	**1**	**2**	**2**
CO6	**3**											**3**	**2**	**1**	**1**	**2**	**2**
1=lightly mapped 2= moderately mapped 3=strongly mapped																	

Semester IV

BSMA802A	FUNCTIONAL ANALYSIS	L	T	P	C
Version 2.0		4	0	0	4
Total Contact Hours	60				
Pre-requisites/Exposure	Linear Algebra and Real Analysis				
Co-requisites	--				

Course Objectives:

The course will enable the students to:

1. Understand the a more advanced concepts such as normed spaces and Banach spaces
2. Describe Inner product with its applications.
3. Know concepts about some fundamental operators

Course Outcomes:

On completion of this course, the students will be able to

CO1. Understand the concept of bounded linear operators
CO2. Connect Hilbert spaces with simple applications
CO3. Apply the notions Adjoint and self-adjoint operators.
CO4. Learn in detail about Hahn Banach theorem and open mapping theorem

Catalog Description:

This course aims to deal with some more advanced concepts in analysis, and it is laid on a preliminary course in linear algebra and real analysis. The course begins with a review of metric spaces with definitions and examples of it. Self-adjoint, unitary and normal operators, Hilbert - adjoint operator are the key concepts in this learning programme. Moreover, some fundamental results such as Hahn Banach theorem, uniform boundedness theorem and open mapping theorem are also considered in the plan of action.

Course Content

Unit I: **14 lecture hours**

Introduction to Normed Spaces

Review of metric spaces, normed spaces, Banach spaces, bounded linear operators and functionals, convergence.

Unit II: **16 lecture hours**

Hilbert Spaces

Inner product spaces, Hilbert spaces with example, projection theorem, othonormal sets and sequences.

Unit III: **14 lecture hours**

Riesz representation theorem

Riesz representation theorem, self-adjoint, unitary and normal operators, Hilbert - adjoint operator

Unit IV: **16 lecture hours**

Hahn Banach Theorem

Hahn Banach theorem, uniform boundedness theorem (Banach-Steinhaus theorem), open mapping theorem and closed graph theorem

Textbooks

1. G. F. Simmons; Introduction to Topology and Modern Analysis, McGraw-Hill.
2. Kreyszig; Introductory Functional analysis with Applications, Wiley India publication.

Reference Books/Materials

3. A. E. Taylor; Introduction to Functional Analysis, John Wiley.
4. N. Dunford and J. T. Schwartz; Linear Operators, Part-I, Interscience.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination/ Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	10	10	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Understand the concept of bounded linear operators	**PO3**
CO2	Connect Hilbert spaces with simple applications	**PO5**
CO3	Apply the notions Adjoint and self-adjoint operators	**PO8**
CO4	Learn in detail about Hahn Banach theorem and open mapping theorem	**PO10**

		Encourage critical thinking to conduct scientific investigations in a biased manner without prejudiced assumptions.	Assist students in analyzing questions, formulating hypotheses, evaluating and validating findings, and drawing logical conclusions.	Prepare students for pursuing research or careers and to design methods to conduct investigations of complex societal and environmental issues.	Continue to acquire relevant knowledge and skills to evaluate the concepts and scientific developments to take up any challenge.	Enhance knowledge mobilization through increased application of mathematics.	Able to use the advance knowledge in consultancy to solve real life problems.	Learn the subject with curiosity to understand new scientific developments.	Understand international perspective about mathematics.	Capability to use appropriate software's to solve mathematical equations.	Develop the protocols as per laboratory standards to accomplish the objectives.	Develop aptitude to formulate concepts based on fundamental axioms of mathematics.	Innovate, invent and solve complex mathematical problems using the knowledge of pure and applied mathematics.	Understand demands of the growing field of Mathematics by lifelong learning.	Develop problem-solving skills, critical thinking, and interest through assignments and project work	Prepare students for competitive examinations such as NET, GATE, and many others.
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
BSMA802A	Functional Analysis		3				3	3		2		3		2		

1=weakly mapped
2= moderately mapped
3=strongly mapped

Programme and Course Mapping																	
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	**2**											**3**	**2**	**1**	**1**	**2**	**2**
CO2								**2**				**3**	**2**	**1**	**1**	**2**	**2**
CO3		**3**										**3**	**2**	**1**	**1**	**2**	**2**
CO4				**2**								**3**	**2**	**1**	**1**	**2**	**2**
CO5			**3**									**3**	**2**	**1**	**1**	**2**	**2**
CO6	**3**											**3**	**2**	**1**	**1**	**2**	**2**
1=lightly mapped 2= moderately mapped 3=strongly mapped																	

BSMA804A	MATHEMATICAL PROGRAMMING	L	T	P	C
Version 2.0		4	0	0	4
Total Contact Hours	60				
Pre-requisites/Exposure					
Co-requisites	--				

Course Objectives

1. Assess critically the utility of a number of mathematical programming techniques.
2. Describe mathematical programming solution strategies and techniques.
3. Use mathematical programming methods to address management decision problems.

Course Outcomes

On completion of this course, the students will be able to

CO1. To formulate a real-world problem as a mathematical programming model
CO2. To apply the appropriate method in order to find an optimal solution
CO3. Understand the problems of mathematical programming and related theorems
CO4. Understands the basics concepts of integer programming (IP) and nonlinear programming (NLP) problems
CO5. Emphasizing the underlying mathematical structures, geometrical ideas, algorithms solutions of relevant practical problem
CO6. Learn about solution of nonlinear programming problems by using Lagrange multiplier and KuhnTucker conditions

Catalogue Description

Optimisation problems are concerned with optimising an objective function subject to a set of constraints. When deterministic optimisation problems are translated in algebraic form, we refer to them as mathematical programs. Mathematical programming, as an area within Operational Research (OR), Management Science (MS) and Business Analytics (BA), is concerned with model building and strategies and methods for solving mathematical programs. In this course, we address model building in OR/MS/BA, present a variety of typical OR/MS/BA problems and their mathematical programming formulations, provide general tips on how to model managerial situations, and discuss solution strategies and present solution methods for linear programs, non-linear programs and integer programs.

Course Content

Unit I: **14 lecture hours**

Unconstrained Optimization Problems

Existence theorems, First order optimality conditions and second order optimality conditions for unconstrained optimization problems

Unit II: **16 lecture hours**

Convex Functions

Convex functions, Differentiable convex functions, Optimization on convex sets, Karush Kuhn Tucker conditions in nonlinear programming, Second order conditions in nonlinear programming

Unit III: **16 lecture hours**

Quadratic Programming

Quadratic programming, Wolfe's method as application of Karush Kuhn Tucker conditions, convex simplex method, Penalty function methods.

Unit IV: **14 lecture hours**

Integer Linear Programming

Integer Linear Programming, Modelling using pure and mixed integer programming, Branch and Bound Technique, Gomory's Cutting Plane Algorithm

Reference Books/Materials

1. Jan Brinkhuis and Vladimir Tikhomirov; Optimization : Insights and Applications, Princeton University Press.
2. Kenneth Lange; Optimization, Springer.
3. Osman Gler; Foundations of Optimization, Springer.
4. David G. Luenberger and Yinyu Ye; Linear and Nonlinear Programming, Springer.
5. Mokhtar S. Bazaraa, Hanif D. Sherali and C.M. Shetty; Nonlinear Programming: Theory and Algorithms, John Wiley & Sons, 2006.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	10	10	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	To formulate a real-world problem as a mathematical programming model	**PO2**
CO2	To apply the appropriate method in order to find an optimal solution	**PO4**
CO3	Understand the problems of mathematical programming and related theorems	**PO3**
CO4	Understands the basics concepts of integer programming (IP) and nonlinear programming (NLP) problems	**PO1**
CO5	Emphasizing the underlying mathematical structures, geometrical ideas, algorithms solutions of relevant practical problem	**PO6**
CO6	Learn about solution of nonlinear programming problems by using Lagrange multiplier and KuhnTucker conditions	**PO5, PO7**

		Encourage critical thinking to conduct scientific investigations in a biased manner without prejudiced assumptions	Assists students in analyzing questions, formulating hypotheses, evaluating and validating findings, and drawing logical conclusions	Prepare students for pursuing research or careers and to design methods to conduct investigations of complex societal and environmental issues. v	Continue to acquire relevant knowledge and skills to evaluate the concepts and scientific developments to take up any challenge.	Enhance knowledge mobilization through increased application of mathematics.	Able to use the advance knowledge in consultancy to solve real life problems.	Learn the subject with curiosity to understand new scientific developments.	Understand international perspective about mathematics.	Capability to use appropriate software's to solve mathematical equations.	Develop the protocols as per laboratory standards to accomplish the objectives.	Develop aptitude toformulate concepts based on fundamental axioms of mathematics	Innovate, invent and solve complex mathematical problems using the knowledge of pure and applied mathematics	Understand demands of the growing field of Mathematics by lifelong learning	Develop problem-solving skills, critical thinking, and interest through assignments and project work	Prepare students for competitive examinations such as NET, GATE, and many others.
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
BSMA804A	Mathematical Programming	2	3	3		2	3	3				3	2	2	2	

1=weakly mapped

2= moderately mapped

3=strongly mapped

Programme and Course Mapping																	
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	**2**											**3**	**2**	**1**	**1**	**2**	**2**
CO2								**2**				**3**	**2**	**1**	**1**	**2**	**2**
CO3		**3**										**3**	**2**	**1**	**1**	**2**	**2**
CO4				**2**								**3**	**2**	**1**	**1**	**2**	**2**
CO5			**3**									**3**	**2**	**1**	**1**	**2**	**2**
CO6	**3**											**3**	**2**	**1**	**1**	**2**	**2**
1=lightly mapped 2= moderately mapped 3=strongly mapped																	

BSMA806A	FUZZY SET AND APPLCATIONS	L	T	P	C
Version 1.0		4	0	0	4
Total Contact Hours	60				
Pre-requisites/Exposure					
Co-requisites	--				

Course Objectives

1. Provide a brief knowledge of Fuzzy sets.
2. Invention the Decomposition of fuzzy sets and power of the fuzzy sets.
3. Determined the Transitivity, involution, Demorgans laws by using the fuzzy sets.
4. Understand the identity the arbitrary collection of fuzzy sets and their applications in social sciences, physical sciences, life sciences and a host of other disciplines.

Course Outcomes

On completion of this course, the students will be able to

1. Applied distinguish between the crisp set and fuzzy set concepts through the learned differences between the crisp set characteristic function and the fuzzy set membership function.
2. Construct the appropriate fuzzy numbers corresponding to uncertain and imprecise collected data.
3. Recognize the fuzzy inference systems in the design of intelligent or humanistic systems.
4. Determine the concept of fuzzy applications to design complex and critical financial models for any organization.
5. Apply the fuzzy application to solve real life problems in different field.

Catalogue Description

The focus of the course is the concepts and techniques for solving the fuzzy sets that permeate various scientific disciplines. Applications include problems from electrical and mechanical engineering, materials science, quantum mechanics, etc. Important objectives of the fuzzy sets and application are to develop and strengthen the students' problem-solving skills and to teach them to read, write, speak, and think in the language of mathematics. In particular, students learn how to apply the tools of calculus to a variety of problem situations.

Course Content

Unit I: 14 lecture hours

Fuzzy concepts: Definition of a fuzzy set and membership function, representation of membership function, General definitions and properties of fuzzy sets, Support, height, equality of two fuzzy sets.

Unit II: **16 lecture hours**

Fuzzy union and intersection: Union and Intersection of fuzzy sets, Complement of a fuzzy set, normal fuzzy set, α- cut set, strong α-cut, convex fuzzy set, Necessary and Sufficient condition for convexity of a fuzzy set, Decomposition of fuzzy sets, Level set of a fuzzy set, Cardinality, fuzzy cardinality, Product of fuzzy sets, Product of a fuzzy set with a crisp number, Power of a fuzzy set, Difference of fuzzy sets, Disjunctive sum of fuzzy sets.

Unit III: **16 lecture hours**

Properties of fuzzy sets: General properties of operations on fuzzy sets, Commutativity, associativity, distributivity, Idempotent law, identities for operations, Transitivity, involution, Demorgans laws, proofs and examples, Some important theorems on fuzzy sets, set inclusion of fuzzy sets and corresponding α-cuts and strong α-cuts.

Unit IV: **14 lecture hours**

Applications of fuzzy sets: Comparison of α-cut and strong α-cut, Order relation of scalars α is inversely preserved by set inclusion of corresponding α-cuts and strong α-cuts, α-cut of union and intersection of two fuzzy sets, α-cut of complement of a fuzzy set, α-cuts and strong α-cuts of union and intersection of arbitrary collection of fuzzy sets.

Textbooks

1. Pundir and Pundir; *Fuzzy Sets and their Applications*, Pragati Prakashan.

Reference Books/Materials

1. G.J. Klir, B.Yuan; *Fuzzy Sets and Fuzzy Logic: Theory and Applications*, Prentice Hall.
2. Hao Ying; *Fuzzy Control and Modeling: Analytical Foundations and Applications*, IEEE Press.
3. T.J. Ross; *Fuzzy Logic with Engineering Applications*, John Wiley & Sons.
4. H.J. Zimmermann; *Fuzzy set theory and its Applications*, Allied Publishers Ltd, New Delhi.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	10	10	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Applied distinguish between the crisp set and fuzzy set concepts through the learned differences between the crisp set characteristic function and the fuzzy set membership function.	**PO1**
CO2	Construct the appropriate fuzzy numbers corresponding to uncertain and imprecise collected data.	**PO8**
CO3	Recognize the fuzzy inference systems in the design of intelligent or humanistic systems.	**PO2**
CO4	Determine the concept of fuzzy applications to design complex and critical financial models for any organization.	**PO4**
CO5	Apply the fuzzy application to solve real life problems in different field.	**PO3**

		Encourage critical thinking to conduct scientific investigations in a biased manner without prejudiced assumptions.	Assist students in analyzing questions, formulating hypotheses, evaluating and validating findings, and drawing logical conclusions.	Prepare students for pursuing research or careers and to design methods to conduct investigations of complex societal and environmental issues.	Continue to acquire relevant knowledge and skills to evaluate the concepts and scientific developments to take up any challenge.	Enhance knowledge mobilization through increased application of mathematics.	Able to use the advance knowledge in consultancy to solve real life problems.	Learn the subject with curiosity to understand new scientific developments.	Understand international perspective about mathematics.	Capability to use appropriate software's to solve mathematical equations.	Develop the protocols as per laboratory standards to accomplish the objectives.	Develop aptitude to formulate concepts based on fundamental axioms of mathematics.	Innovate, invent and solve complex mathematical problems using the knowledge of pure and applied mathematics.	Understand demands of the growing field of Mathematics by lifelong learning.	Develop problem-solving skills, critical thinking, and interest through assignments and project work.	Prepare students for competitive examinations such as NET, GATE, and many others.
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
BSMA806A	Fuzzy sets and applications	2	3	3	2				2			3		3	2	

1=weakly mapped
2= moderately mapped
3=strongly mapped

Programme and Course Mapping																	
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	**2**											**3**	**2**	**1**	**1**	**2**	**2**
CO2								**2**				**3**	**2**	**1**	**1**	**2**	**2**
CO3		**3**										**3**	**2**	**1**	**1**	**2**	**2**
CO4				**2**								**3**	**2**	**1**	**1**	**2**	**2**
CO5			**3**									**3**	**2**	**1**	**1**	**2**	**2**
CO6	**3**											**3**	**2**	**1**	**1**	**2**	**2**
1=lightly mapped 2= moderately mapped 3=strongly mapped																	

BSMA809A	FLUID DYNAMICS	L	T	P	C
Version 2.0		4	0	0	4
Total Contact Hours	60				
Pre-requisites/Exposure					
Co-requisites	--				

Course Objectives

The objective of this course is to introduce fundamental aspects of fluid flow behaviour and to develop steady state mechanical energy balance equation for fluid flow systems, estimate pressure drop in fluid flow systems and determine performance characteristics of fluid machinery.

Course Outcomes

This course will enable the students to:

CO1. Develop appreciation properties of fluids
CO2. Derived Euler's equation, Bernoulli's equation and Discuss the case of steady motions under conservative body forces.
CO3. Apply concepts of mass, momentum and energy conservation to flows,
CO4. Prove Milne- Thomson Circle theorem and derived some application.
CO5. Understand the concept of elements of thermodynamics and explain Entropy-Maxwell's Thermodynamics relation

Catalogue Description

After completing this course the student able to: study of Fluid motion, Lagrangian and Eulerian methods , Euler's and Lagrange's Equation of continuity and equation of motion , Newton's law of viscosity Navier-Stokes equations of motion, Steady viscous flow between parallel planes.

Course Content

Unit I: **14 lecture hours**

Introduction to Fluid Flows

Classification of fluid flows - viscous flow, compressible flow, steady flow, uniform flow, laminar flow, turbulent flow, Properties of fluids.

Unit II: **16 lecture hours**

Fluid Kinematics

Fluid kinematics - Lagrangian and Eulerian Descriptions, Flow Patterns - streamlines and streamtubes, pathlines, streaklines, timelines, Vorticity and rotationality, The Reynolds Transport Theorem

Unit III: **14 lecture hours**

Law of Conservation of Mass

Conservation of mass, Conservation of energy, Mass and volume flow rates, The Linear Momentum Equation, Bernoulli Equation, General Energy Equation

Unit IV: **16 lecture hours**

Navier-Stokes Equations

Laminar flow in pipes, Turbulent flow in pipes, Newtonian versus Non-Newtonian fluids, The Navier–Stokes Equation, Continuity and Navier–Stokes equations

Textbooks

1. W. H. Besant and A.S. Ramsey; *A Treatise on Hydromechanics*, Part-II, CBS Publishers.
2. F. Chorlton; *Text-book of Fluid Dynamics*, C. B. S. Publishers, Delhi.
3. Michael E.O. Neill and F. Chorlton; *Ideal and Incompressible Fluid Dynamics*, John Wiley &Sons.
4. R.K. Rathy. *An Introduction to Fluid Dynamics*, Oxford and IBH Publishing Company.
5. A.J. Chorin and A. Marsden, *A Mathematical Introduction to Fluid Dynamics* Springer-Verlag, New York.
6. L.D. Landau and E.M. Lipschitz, *Fluid Mechanics*, Pergamon Press, London.
7. G. K. Batchelor; *An Introduciton to Fluid Mechanics*, Foundation Books, New Delhi.

Reference Books/Materials

1. J.F. Wendt, J.D. Anderson, G.Degrez and E. Dick, Computational Fluid Dynamics : An Introduction, Springer-Verlag, 1996.

2. J.D. Anderson, Computational Fluid Dynamics, The Basics with Applications, McGraw Hill, 1995.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	10	10	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Develop appreciation properties of fluids	**PO1**
CO2	Derived Euler's equation, Bernoulli's equation and Discuss the case of steady motions under conservative body forces.	**PO3**
CO3	Apply concepts of mass, momentum and energy conservation to flows	**PO5**
CO4	Prove Milne- Thomson Circle theorem and derived some application.	**PO9**
CO5	Understand the concept of elements of thermodynamics and explain Entropy-Maxwell's Thermodynamics relation	**PO8**

		Encourage critical thinking to conduct scientific investigations in a biased manner without prejudiced assumptions.	Assist students in analyzing questions, formulating hypotheses, evaluating and validating findings, and drawing logical conclusions.	Prepare students for pursuing research or careers and to design methods to conduct investigations of complex societal and environmental issues.	Continue to acquire relevant knowledge and skills to evaluate the concepts and scientific developments to take up any challenge.	Enhance knowledge mobilization through increased application of mathematics.	Able to use the advance knowledge in consultancy to solve real life problems.	Learn the subject with curiosity to understand new scientific developments.	Understand international perspective about mathematics.	Capability to use appropriate software's to solve mathematical equations.	Develop the protocols as per laboratory standards to accomplish the objectives.	Develop aptitude to formulate concepts based on fundamental axioms of mathematics.	Innovate, invent and solve complex mathematical problems using the knowledge of pure and applied mathematics.	Understand demands of the growing field of Mathematics by lifelong learning.	Develop problem-solving skills, critical thinking, and interest through assignments and project work	Prepare students for competitive examinations such as NET, GATE, and many others.
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
BSMA 809A	Fluid Dynamics	2		2		3			2	2						

1=weakly mapped
2= moderately mapped
3=strongly mapped

Programme and Course Mapping																	
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	**2**											**3**	**2**	**1**	**1**	**2**	**2**
CO2								**2**				**3**	**2**	**1**	**1**	**2**	**2**
CO3		**3**										**3**	**2**	**1**	**1**	**2**	**2**
CO4				**2**								**3**	**2**	**1**	**1**	**2**	**2**
CO5			**3**									**3**	**2**	**1**	**1**	**2**	**2**
CO6	**3**											**3**	**2**	**1**	**1**	**2**	**2**
1=lightly mapped 2= moderately mapped 3=strongly mapped																	

BSMA812A	MATHEMATICAL BIOLOGY	L	T	P	C
Version 2.0		4	0	0	4
Total Contact Hours	60				
Pre-requisites/Exposure					
Co-requisites	--				

Course Objectives

1. Finding the equilibria of a single-population model and their stability
2. Analysis of equilibria and stability of a delay-differential equation
3. Ability to analyse nonlinear PDE for travelling wave solution
4. Analysis and stability of equilibria of planar nonlinear system
5. Analysis and stability of equilibria of nonlinear systems in more than two variables.
6. Familiarity with biological applications as stated in the syllabus

Course Outcomes

On completion of this course, the students will be able to

CO1- To enhanced knowledge and understanding of mathematical modeling and statistical methods in the analysis of biological

CO2- Choose and apply computational tools to perform parameter estimation and to solve discrete and differential equation models.

CO3- Be better able to assess biological inferences that rest on mathematical and statistical arguments;

CO4: To analyses data from experiments and draw sound conclusions about the underlying processes using their understanding of mathematics and statistics;

CO5 To use of computers to assist them in studying mathematical functions and carrying out statistical tests.

CO6- To analysis of biological processes and data, including simple computer programming by using software

Catalogue Description

This course gives an introduction to mathematical modelling and data analysis for biological and biomedical systems. Examples include: the formation of animal coat patterns, the spread of diseases through the community, the interaction between pathogens and the immune system of the body, the growth of tumours, nerve cell signaling, population dynamics, pharmacokinetics and bacterial growth. The emphasis in this course is on the development of the governing model equations and on computer simulations of the model equations rather than on mathematical methods for solving the model equation

Course Content

UNIT – I **14 lecture hours**

Introduction to Mathematical Biology

Mathematical Biology and the modeling process: an overview. Continuous models: Malthus model, logistic growth, Allee effect, Gompertz growth, Michaelis-Menten Kinetics, Holling type growth, Bacterial growth in a Chemostat, Harvesting a single natural population, Prey predator systems and Lotka Volterra equations,

Unit II: **16 lecture hours**

Population Models

Populations in competitions, Epidemic Models (SI, SIR, SIRS, SIC), Activator-Inhibitor system, Insect Outbreak Model: Spruce Budworm, Numerical solution of the models and its graphical representation. Qualitative analysis of continuous models: Steady state solutions, stability and linearization, multiple species communities and Routh-Hurwitz Criteria,

Unit III: **16 lecture hours**

Phase Plane Methods

Phase plane methods and qualitative solutions, bifurcations and limit cycles with examples in the context of biological scenario. Spatial Models: One species model with diffusion, Two species model with diffusion, Conditions for diffusive instability, Spreading colonies of microorganisms, Blood flow in circulatory system, Travelling wave solutions, Spread of genes in a population.

Unit IV: **14 lecture hours**

Discrete Models

Discrete Models: Overview of difference equations, steady state solution and linear stability analysis, Introduction to Discrete Models, Linear Models, Growth models, Decay models, Drug Delivery Problem, Discrete Prey-Predator models, Density dependent growth models with harvesting, Host-Parasitoid systems (Nicholson-Bailey model), Numerical solution of the models and its graphical representation. Case Studies: Optimal Exploitation models, Models in Genetics, Stage Structure Models, Age Structure Models.

Reference Books/Materials

1. L.E. Keshet, *Mathematical Models in Biology*, SIAM, 1988.
2. J. D. Murray, *Mathematical Biology*, Springer, 1993.
3. Y.C. Fung, *Biomechanics*, Springer-Verlag, 1990.
4. F. Brauer, P.V.D. Driessche and J. Wu, *Mathematical Epidemiology*, Springer, 2008.
5. M. Kot, *Elements of Mathematical Ecology*, Cambridge University Press, 2001.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	10	10	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	Mapped Program Outcomes
CO1	To enhanced knowledge and understanding of mathematical modeling and statistical methods in the analysis of biological	PO7
CO2	Choose and apply computational tools to perform parameter estimation and to solve discrete and differential equation models.	PO2
CO3	Be better able to assess biological inferences that rest on mathematical and statistical arguments;	PO3
CO4	To analyses data from experiments and draw sound conclusions about the underlying processes using their understanding of mathematics and statistics;	PO3
CO5	To use of computers to assist them in studying mathematical functions and carrying out statistical tests.	PO6
CO6	To analysis of biological processes and data, including simple computer programming by using software	PO5

		Encourage critical thinking to conduct scientific investigations in a biased manner without prejudiced assumptions	Assists students in analyzing questions, formulating hypotheses, evaluating and validating findings, and drawing logical conclusions	Prepare students for pursuing research or careers and to design methods to conduct investigations of complex societal and environmental issues. v	Continue to acquire relevant knowledge and skills to evaluate the concepts and scientific developments to take up any challenge.	Enhance knowledge mobilization through increased application of mathematics.	Able to use the advance knowledge in consultancy to solve real life problems.	Learn the subject with curiosity to understand new scientific developments.	Understand international perspective about mathematics.	Capability to use appropriate software's to solve mathematical equations.	Develop the protocols as per laboratory standards to accomplish the objectives.	Develop aptitude toformulate concepts based on fundamental axioms of mathematics	Innovate, invent and solve complex mathematical problems using the knowledge of pure and applied mathematics	Understand demands of the growing field of Mathematics by lifelong learning	Develop problem-solving skills, critical thinking, and interest through assignments and project work	Prepare students for competitive examinations such as NET, GATE, and many others.
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
BSMA812A	Mathematical Biology		3	2		3	3	3				2	2		2	2

1=weakly mapped
2= moderately mapped
3=strongly mapped

Programme and Course Mapping																	
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	**2**											**3**	**2**	**1**	**1**	**2**	**2**
CO2								**2**				**3**	**2**	**1**	**1**	**2**	**2**
CO3		**3**										**3**	**2**	**1**	**1**	**2**	**2**
CO4				**2**								**3**	**2**	**1**	**1**	**2**	**2**
CO5			**3**									**3**	**2**	**1**	**1**	**2**	**2**
CO6	**3**											**3**	**2**	**1**	**1**	**2**	**2**
1=lightly mapped 2= moderately mapped 3=strongly mapped																	

BSMA818A	DISCRETE MATHEMATICS	L	T	P	C
Version 1.0		4	0	0	4
Total Contact Hours	60				
Pre-requisites/Exposure	Computer Programming				
Co-requisites	--				

Course Objectives

1 To apply basic algorithmic techniques such as greedy algorithms, binary search, sorting and dynamic programming to solve programming challenges.
2 To apply graph and string algorithms to solve real-world challenges: finding shortest paths on huge maps and assembling genomes from millions of pieces.
3 To apply various data structures such as stack, queue, hash table, priority queue, binary search tree, graph and string to solve programming challenges.
4 To solve complex programming challenges using advanced techniques: maximum flow, linear programming, approximate algorithms, SAT-solvers, streaming.

Course Outcomes

On completion of this course, the students will be able to know

CO1 Apply counting principles to determine probabilities.
CO2 Simplify and evaluate basic logic statements including compound statements, implications, inverses, converses, and contrapositives using truth tables and the properties of logic.
CO3 Evaluate Boolean functions and simplify expression using the properties of Boolean algebra; apply Boolean algebra to circuits and gating networks.
CO4 Represent a graph and apply graph theory to application problems such as computer networks.
CO5 Demonstrate different traversal methods for trees and graphs.
CO6 Model problems in Computer Science using graphs and trees.

Catalog Description

Discrete mathematics forms the mathematical foundation of computer and information science. It is also a fascinating subject in itself. Discrete Math is needed to see mathematical structures in the object you work with, and understand their properties. This ability is important for software engineers, data scientists, security and financial analysts (it is not a coincidence that math puzzles are often used for interviews). We cover the basic notions and results (combinatorics, graphs, probability, number theory) that are universally needed. To deliver techniques and ideas in discrete mathematics to the learner we extensively use interactive puzzles specially created for this specialization. To bring the learners experience closer to IT-applications we incorporate programming examples, problems and projects in our courses.

Course Content

UNIT-I **14 lecture hours**

Counting and Generating Functions: Basic counting principles, Permutations and Combinations, Binomial theorem, Multinomial theorem, Counting subsets, Set-partitions, Stirling numbers. Principle of Inclusion and Exclusion, Derangements, Inversion formulae.
Algebra of formal power series, Generating function models, Calculating generating functions, Exponential generating functions.

UNIT-II **16 lecture hours**

Boolean Algebra: Lattices, Complete lattices, Lattices as algebraic structures, Sublattices, Products and Homomorphisms, Modular and Distributive lattices, Boolean polynomials, minimal forms of Boolean polynomials, Quinn-McCluskey method, Karnaugh diagrams, Switching circuits.

UNIT-III **16 lectures hours**

Graph theory: Directed graph, Euler graph, Hamiltonian graph, Matrix representation of graphs, Shortest path in a weighted graph, K- connected and K- edge connected graphs, Planar graphs, Coloring of graphs, Vizing's theorem.

UNIT-IV **14 lecture hours**

Trees: Rooted trees, Spanning tree and Cut set, Minimum-spanning tree, Flow network in a graph, max-flow-min cut theorem.

Reference Books/Materials

1. C.L. Liu & Mahopatra; *Elements of Discrete mathematics*, Tata McGraw Hill.
2. N. Deo, Graph Theory with Applications to Computer Science, Prentice-Hall of India.
3. T.H. Coremen, C.E. Leiserson, R. L. Rivest; *Introduction to algorithms*, Prentice Hall on India.
4. M. O. Albertson and J. P. Hutchinson; *Discrete Mathematics with Algorithms*, Johnwiley Publication.
5. J. L. Hein; *Discrete Structures, Logic, and Computability*, Jones and Bartlett Publishers.
6. Kenneth H. Rosen; *Discrete Mathematics and Its Applications*, McGraw-Hill Education.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	10	10	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Apply counting principles to determine probabilities.	**PO1**
CO2	Simplify and evaluate basic logic statements including compound statements, implications, inverses, converses, and contrapositives using truth tables and the properties of logic.	**PO2**
CO3	Evaluate Boolean functions and simplify expression using the properties of Boolean algebra; apply Boolean algebra to circuits and gating networks.	**PO3**
CO4	Represent a graph and apply graph theory to application problems such as computer networks.	**PO7**
CO5	Demonstrate different traversal methods for trees and graphs.	**PO10**
CO6	Model problems in Computer Science using graphs and trees.	**PO8**

		Encourage critical thinking to conduct scientific investigations in a biased manner without prejudiced assumptions.	Assist students in analyzing questions, formulating hypotheses, evaluating and validating findings, and drawing logical conclusions.	Prepare students for pursuing research or careers and to design methods to conduct investigations of complex societal and environmental issues.	Continue to acquire relevant knowledge and skills to evaluate the concepts and scientific developments to take up any challenge.	Enhance knowledge mobilization through increased application of mathematics.	Able to use the advance knowledge in consultancy to solve real life problems.	Learn the subject with curiosity to understand new scientific developments.	Understand international perspective about mathematics.	Capability to use appropriate software's to solve mathematical equations.	Develop the protocols as per laboratory standards to accomplish the objectives.	Develop aptitude to formulate concepts based on fundamental axioms of mathematics.	Innovate, invent and solve complex mathematical problems using the knowledge of pure and applied mathematics.	Understand demands of the growing field of Mathematics by lifelong learning.	Develop problem-solving skills, critical thinking, and interest through assignments and project work	Prepare students for competitive examinations such as NET, GATE, and many others.
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
BSMA818A	Discrete Mathematics	2	2	2				3	3		3	2		3	3	

1=weakly mapped
2= moderately mapped
3=strongly mapped

Programme and Course Mapping																	
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO11**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	**PSO 6**
CO 1	**2**											**3**	**2**	**1**	**1**	**2**	**2**
CO 2								**2**				**3**	**2**	**1**	**1**	**2**	**2**
CO 3		**3**										**3**	**2**	**1**	**1**	**2**	**2**
CO 4				**2**								**3**	**2**	**1**	**1**	**2**	**2**
CO 5			**3**									**3**	**2**	**1**	**1**	**2**	**2**
CO 6	**3**											**3**	**2**	**1**	**1**	**2**	**2**
1=lightly mapped 2= moderately mapped 3=strongly mapped																	

BSMA828A	NUMBER THEORY	L	T	P	C
Version 1.0		4	0	0	4
Total Contact Hours	60				
Pre-requisites/Exposure					
Co-requisites	--				

Course Objectives

Number theory is primarily the study of integers and their properties. To present a rigorous development of Number Theory using axioms, definitions, examples, theorems and their proofs. The course provides students an opportunity to develop an appreciation of pure mathematics while engaged in the study of basic number theoretic results. The course is also designed to provide students an opportunity to work with conjectures, proofs, and analyzing mathematics.

Course Outcomes

This course will enable the students to:

CO1. Define and interpret the concepts of divisibility, congruence, greatest common divisor, prime numbers and Arithmetical functions.

CO2. Prove statements and solve problems involving divisibility, prime numbers and quadratic residues.

CO3. Solve various types of congruence problems and use theory of congruences in applications.

CO4. Construct mathematical proofs of existence of primitive roots modulo m

CO5. Apply techniques to solve linear Diophantine equations. Apply properties of multiplicative functions such as Euler's Phi function and Mobius function.

Catalog Description

After completing this course the student able to: Understand the properties of divisibility and prime numbers, compute the greatest common divisor and least common multiples, operations with congruences and use the Lagrane theorem, Fermat's theorem, Chinese remainder theorem.

Course Content

Unit I: 14 lecture hours

Linear Equations

The equation ax+by = c, simultaneous linear equations, Pythagorean triangles, assorted examples, ternary quadratic forms, rational points on curves.

Unit II: **16 lecture hours**

Elliptic Curves

Elliptic curves, Factorization using elliptic curves, curves of genus greater than 1. Farey sequences, rational approximations, Hurwitz theorem, irrational numbers, Geometry of Numbers, Blichfeldt's principle, Minkowski's Convex body theorem Lagrange's four square theorem.

Unit III: **14 lecture hours**

Approximations

Euclidean algorithm, infinite continued fractions, irrational numbers, approximations to irrational numbers, Best possible approximations, Periodic continued fractions, Pell's equation.

Unit IV: **16 lecture hours**

Euler's formula

Partitions, Ferrers Graphs, Formal power series, generating functions and Euler's identity, Euler's formula, bounds on P(n), Jacobi's formula, a divisibility property.

Textbooks

1. G.H. Hardy, and E.M. Wright; *An Introduction to the Theory of Numbers*, Oxford Science Publications
2. D.M. Burton; *Elementary Number Theory*, McGraw Hill
3. N.H. McCoy; *The Theory of Number*, McMillan.
4. Ivan Niven, Herbert S. Zuckerman, Hugh L. Montgomery; *An Introduction to the Theory of Number*s, John Wiley & Sons(Asia)Pte.Ltd.

Reference Books/Materials

1.Neville Robbins (2007). Beginning Number Theory (2nd edition). Narosa.
2.I.Niven (2012). An Introduction to the Theory of Numbers (5th edition). John Wiley & Sons.
3.Neal Koblitz (1994). A Course in Number Theory and Cryptography (2nd edition). Springer-Verlag.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	10	10	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Define and interpret the concepts of divisibility, congruence, greatest common divisor, prime numbers and Arithmetical functions.	**PO1**
CO2	Prove statements and solve problems involving divisibility, prime numbers and quadratic residues.	**PO3**
CO3	Solve various types of congruence problems and use theory of congruences in applications	**PO5**
CO4	Construct mathematical proofs of existence of primitive roots modulo m	**PO9**
CO5	Apply techniques to solve linear Diophantine equations. Apply properties of multiplicative functions such as Euler's Phi function and Mobius function.	**PO8**

		Encourage critical thinking to conduct scientific investigations in a biased manner without prejudiced assumptions.	Assist students in analyzing questions, formulating hypotheses, evaluating and validating findings, and drawing logical conclusions.	Prepare students for pursuing research or careers and to design methods to conduct investigations of complex societal and environmental issues.	Continue to acquire relevant knowledge and skills to evaluate the concepts and scientific developments to take up any challenge.	Enhance knowledge mobilization through increased application of mathematics.	Able to use the advance knowledge in consultancy to solve real life problems.	Learn the subject with curiosity to understand new scientific developments.	Understand international perspective about mathematics.	Capability to use appropriate software's to solve mathematical equations.	Develop the protocols as per laboratory standards to accomplish the objectives.	Develop aptitude to formulate concepts based on fundamental axioms of mathematics.	Innovate, invent and solve complex mathematical problems using the knowledge of pure and applied mathematics.	Understand demands of the growing field of Mathematics by lifelong learning.	Develop problem-solving skills, critical thinking, and interest through assignments and project work	Prepare students for competitive examinations such as NET, GATE, and many others.
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
BSMA828A	Number Theory	2		2		3			2	2		2	2			3

1=weakly mapped
2= moderately mapped
3=strongly mapped

Programme and Course Mapping																	
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	**2**											**3**	**2**	**1**	**1**	**2**	**2**
CO2								**2**				**3**	**2**	**1**	**1**	**2**	**2**
CO3		**3**										**3**	**2**	**1**	**1**	**2**	**2**
CO4				**2**								**3**	**2**	**1**	**1**	**2**	**2**
CO5			**3**									**3**	**2**	**1**	**1**	**2**	**2**
CO6	**3**											**3**	**2**	**1**	**1**	**2**	**2**
1=lightly mapped 2= moderately mapped 3=strongly mapped																	

BSMA830A	ADVANCED MESURE THEORY	L	T	P	C
Version 1.0		4	0	0	4
Total Contact Hour	60				
Pre-requisites/Exposure					
Co-requisites	--				

Course Objectives

1. To provide a concrete setting of Lebesgue measure and Lebesgue integral via the classical concepts of Jordan measure and the Riemann integration.
2. To give an expert and thorough study on abstract measuresa and the modern integation theory including the standard convergence theorems.
3. To introduce product measure and study the Fubini's theorem.

Course Outcomes

This course will enable the students to:

CO1. Discuss about the importance of monotone convergence theorem, dominated convergence theorem and Fauto's lemma.

CO2. Discuss the concept of sigma algebra and their examples. Student will be able to understand the set of all Lebesque measurable set is a sigma algebra.

CO3. Prove the completeness of Lp spaces.

CO4. Understand the proof and apply Fubini's theorem in various cases

CO5. Comprehend the idea of Hahn and Jordan decomposition and Radon nikodym theorems.

Catalog Description

After completing this course the student able to: To provide a concrete setting of Lebesgue measure and Lebesgue integral via the classical concepts of Jordan measure and the Riemann integration. To give an expert and thorough study on abstract measures and to introduce product measure and study the Fubini's theorem

Course Content

Unit I: **14 lecture hours**

Lebesgue Measure

Review of Lebesgue measure and integral, Signed measure, Complex measure Multi-dimensional Lebesgue measure

Unit II: **16 lecture hours**

Riesz Representation Theorem

Construction of the product measure, Fubini's Theorem, L^p spaces, Riesz representation theorem for bounded linear functionals on L^p spaces, Convergence in measure

Unit III: **14 lecture hours**

Singular Measure

Singular measures, Lebesgue-Stieltjes measures, Hahn decomposition theorem,

Unit IV: **16 lecture hours**

Decomposition Theorems

Jordan decomposition theorem, Radon-Nikodym theorem, Lebesgue decomposition theorem

Textbooks

1.H. L. Royden, *Real Analysis*, 3rd Edition, Prentice Hall, 1988.
2.P. R. Halmos, *Measure Theory*, East-West Press Pvt. Ltd., 1978.
3.M. E. Taylor, *Measure Theory*, American Mathematical Society, 2006.

Reference Books/Materials

1. Theodore W. Gamelin, Complex Analysis, Springer Verlag, 2001.
2. Donald Sarason, Notes on Complex Function theory, Hindustan Book Agency, 1994.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	10	10	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Discuss about the importance of monotone convergence theorem, dominated convergence theorem and Fauto's lemma.	**PO1**
CO2	Discuss the concept of sigma algebra and their examples. Student will be able to understand the set of all Lebesque measurable set is a sigma algebra.	**PO3**
CO3	Prove the completeness of Lp spaces.	**PO5**
CO4	Understand the proof and apply Fubini's theorem in various cases	**PO9**
CO5	Comprehend the idea of Hahn and Jordan decomposition and Radon nikodym theorems.	**PO8**

		Encourage critical thinking to conduct scientific investigations in a biased manner without prejudiced assumptions.	Assist students in analyzing questions, formulating hypotheses, evaluating and validating findings, and drawing logical conclusions.	Prepare students for pursuing research or careers and to design methods to conduct investigations of complex societal and environmental issues.	Continue to acquire relevant knowledge and skills to evaluate the concepts and scientific developments to take up any challenge.	Enhance knowledge mobilization through increased application of mathematics.	Able to use the advance knowledge in consultancy to solve real life problems.	Learn the subject with curiosity to understand new scientific developments.	Understand international perspective about mathematics.	Capability to use appropriate software's to solve mathematical equations.	Develop the protocols as per laboratory standards to accomplish the objectives.	Develop aptitude to formulate concepts based on fundamental axioms of mathematics.	Innovate, invent and solve complex mathematical problems using the knowledge of pure and applied mathematics.	Understand demands of the growing field of Mathematics by lifelong learning.	Develop problem-solving skills, critical thinking, and interest through assignments and project work	Prepare students for competitive examinations such as NET, GATE, and many others.
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
BSMA 830 A	Advanced Measure Theory	2		2		3			2	2			2		2	3

1=weakly mapped

2= moderately mapped

3=strongly mapped

Programme and Course Mapping																	
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	**2**											**3**	**2**	**1**	**1**	**2**	**2**
CO2								**2**				**3**	**2**	**1**	**1**	**2**	**2**
CO3		**3**										**3**	**2**	**1**	**1**	**2**	**2**
CO4				**2**								**3**	**2**	**1**	**1**	**2**	**2**
CO5			**3**									**3**	**2**	**1**	**1**	**2**	**2**
CO6	**3**											**3**	**2**	**1**	**1**	**2**	**2**
1=lightly mapped 2= moderately mapped 3=strongly mapped																	

BSMA832A	THEORY OF BOUNDED OPERATORS	L	T	P	C
Version 1.0		3	1	0	4
Total Contact Hour	60				
Pre-requisites/Exposure	Introductory functional analysis course				
Co-requisites	--				

Course Objectives

1. To make students aware of some more advanced concepts they usually do not go through in their introductory functional analysis course
2. To study of operators and their properties on linear spaces

Course Outcomes

This course will enable the students to:

CO1. Describe spectrum of a bounded operator
CO2. Understand different types of convergence
CO3. Grasp properties of compact linear operators
CO4. Apply spectral theory of self-adjoint operators

Catalog Description

The course begins with the spectrum of a bounded operator and moves forward with weak, strong and uniform operator convergence on the space of bounded linear operators. Spectral mapping theorem for polynomials and properties of compact linear operators are the key concepts in this programme. Additionally, singular values, polar decomposition and spectral theory of self-adjoint operators are also considered in the scheme.

Course Content

Unit I: **14 lecture hours**

Convergence of Operator

Spectrum of a bounded operator, uniform, strong and weak operator convergence on the space of bounded linear operators

Unit II: **16 lecture hours**

Spectrum Analysis

Approximate point spectrum and compression spectrum, spectral mapping theorem for polynomials

Unit III: **14 lecture hours**

Adjoint Operator

Compact linear operators and their properties, adjoint of compact operators, the Fredholm alternative spectral properties of self-adjoint operators, positive operators and their properties

Unit IV: **16 lecture hours**

Self-adjoint Operator

spectral representation of a self adjoint compact operator, spectral family of a self-adjoint operator and its properties, continuous functions of self-adjoint operators, polar decomposition, singular values, trace class operators, trace norm and trace, Hilbert-Schmidt operators

Textbooks

1. J.E. Conway, A course in Operator Theory, Graduate Studies in Mathematics, Volume 21, AMS, 1999.
2. N. Dunford and J. T. Schwartz; Linear Operators, Part-I, Interscience.

Reference Books/Materials

1. Martin Schechter, Principles of Functional Analysis, American Mathematical Society, 2004

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	10	10	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	Mapped Program Outcomes
CO1	Describe spectrum of a bounded operator	PO4
CO2	Understand different types of convergence	PO7
CO3	Grasp properties of compact linear operators	PO3
CO4	Apply spectral theory of self-adjoint operators	PO8

		Encourage critical thinking to conduct scientific investigations in a biased manner without prejudiced assumptions.	Assist students in analyzing questions, formulating hypotheses, evaluating and validating findings, and drawing logical conclusions.	Prepare students for pursuing research or careers and to design methods to conduct investigations of complex societal and environmental issues.	Continue to acquire relevant knowledge and skills to evaluate the concepts and scientific developments to take up any challenge.	Enhance knowledge mobilization through increased application of mathematics.	Able to use the advance knowledge in consultancy to solve real life problems.	Learn the subject with curiosity to understand new scientific developments.	Understand international perspective about mathematics.	Capability to use appropriate software's to solve mathematical equations.	Develop the protocols as per laboratory standards to accomplish the objectives.	Develop aptitude to formulate concepts based on fundamental axioms of mathematics.	Innovate, invent and solve complex mathematical problems using the knowledge of pure and applied mathematics.	Understand demands of the growing field of Mathematics by lifelong learning.	Develop problem-solving skills, critical thinking, and interest through assignments and project work	Prepare students for competitive examinations such as NET, GATE, and many others.
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
BSMA 832 A	Theory of Bounded Operators		3	3			2	3					3		2	

1=weakly mapped
2= moderately mapped
3=strongly mapped

Programme and Course Mapping																	
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	**2**											**3**	**2**	**1**	**1**	**2**	**2**
CO2								**2**				**3**	**2**	**1**	**1**	**2**	**2**
CO3		**3**										**3**	**2**	**1**	**1**	**2**	**2**
CO4				**2**								**3**	**2**	**1**	**1**	**2**	**2**
CO5			**3**									**3**	**2**	**1**	**1**	**2**	**2**
CO6	**3**											**3**	**2**	**1**	**1**	**2**	**2**
1=lightly mapped 2= moderately mapped 3=strongly mapped																	

BSMA834A	HARMONIC ANALYSIS	L	T	P	C
Version 1.0		4	0	0	4
Total Contact Hour	60				
Pre-requisites/Exposure	Graduate level knowledge of mathematical analysis				
Co-requisites	--				

Course Objectives

After successful completion of this course students will be able to

1. Continue more advanced study in this area.
2. Understand application of Fourier series and Transforms
3. Differentiate between hamonic analysis and harmonic synthesis.
4. Analyze application of harmonic analysis in physics and Electrical Engineering.

Course Outcomes

On completion of this course, the students will be able to

CO1. Understand application of Fourier series and Fourier Transform
CO2. Apply concepts of Harmonic analysis on Data Science
CO3. Analyze Haar and Plancherel measures on topological groups
CO4. Create and solve their own problems related to signals

Catalog Description

The goal of this course is to provide an introduction into a range of topics and techniques in harmonic analysis, covering material that is interesting not only to students of pure mathematics, but also to those interested in applications in computer science, engineering, physics, and so on.

This course imparts the basic concepts Harmonic Analysis. It enables students to develop correlation between signals and Fourier series. This course helps students in variety of ways to solve the problems based upon different topological space. The course introduces the basic concepts about Haar measure on topological spaces.

Course Content

Unit I: **16 lecture hours**

Basics of Fourier Series

Cassical Fourier series on the unit circle, Fourier coefficients, Cesaro means of the Fourier series, Fourier series of square summable functions.

Unit II: **16 lecture hours**

Convergence of Fourier Series

Convergence of Fourier Series- Convergence in norm, Convergence and divergence at a point, absolutely convergent Fourier series, classic kernels – Poisson, Fejer and Dirichlet

Unit III: **16 lecture hours**

Basic Properties of Topological Groups

Basic properties of topological groups, Haar measure on topological groups with emphasis on R, Z and T, The Banach space $L^1(G)$, convolution with special emphasis on $L^1(R)$, $L^1(Z)$ and $L^1(T)$

Unit IV: **12 lecture hours**

Plancherel Theorem

Plancherel theorem on abelian groups, Plancherel measure on R, Z and T maximal ideal space of $L^1(G)$ (G an abelian topological group).

Textbooks

1. Yitzhak Katznelson, *An Introduction to Harmonic Analysis*, Cambridge University Press, 2004.
2. Henry Helson, *Harmonic Analysis*, Addition-Wesley Publishing Company, 1983.
3. Elias M. Stein & Rami Shakarchi, *Fourier Analysis: An introduction*, Princeton University Press, 2003.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	10	10	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	Mapped Program Outcomes
CO1	Understand application of Fourier series and Fourier Transform	PO1,PO7
CO2	Apply concepts of Harmonic analysis on Data Science	PO5,PO7
CO3	Analyze Haar and Plancherel measures on topological groups	PO8,PO7
CO4	Create and solve their own problems related to signals	PO4,PO7

		Encourage critical thinking to conduct scientific investigations in a biased manner without prejudiced assumptions.	Assist students in analyzing questions, formulating hypotheses, evaluating and validating findings, and drawing logical conclusions.	Prepare students for pursuing research or careers and to design methods to conduct investigations of complex societal and environmental issues.	Continue to acquire relevant knowledge and skills to evaluate the concepts and scientific developments to take up any challenge.	Enhance knowledge mobilization through increased application of mathematics.	Able to use the advance knowledge in consultancy to solve real life problems.	Learn the subject with curiosity to understand new scientific developments.	Understand international perspective about mathematics.	Capability to use appropriate software's to solve mathematical equations.	Develop the protocols as per laboratory standards to accomplish the objectives.	Develop aptitude to formulate concepts based on fundamental axioms of mathematics.	Innovate, invent and solve complex mathematical problems using the knowledge of pure and applied mathematics.	Understand demands of the growing field of Mathematics by lifelong learning.	Develop problem-solving skills, critical thinking, and interest through assignments and project work	Prepare students for competitive examinations such as NET, GATE, and many others.
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
BSMA834A	Harmonic Analysis	1			2	2		3	2				3	1	3	

1=weakly mapped

2= moderately mapped

3=strongly mapped

Programme and Course Mapping																	
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	**2**											**3**	**2**	**1**	**1**	**2**	**2**
CO2								**2**				**3**	**2**	**1**	**1**	**2**	**2**
CO3		**3**										**3**	**2**	**1**	**1**	**2**	**2**
CO4				**2**								**3**	**2**	**1**	**1**	**2**	**2**
CO5			**3**									**3**	**2**	**1**	**1**	**2**	**2**
CO6	**3**											**3**	**2**	**1**	**1**	**2**	**2**
1=lightly mapped 2= moderately mapped 3=strongly mapped																	

BSMA852A	DISSERTATION	L	T	P	C
Version 1.0		0	0	0	6
Pre-requisites/Exposure	--				
Co-requisites	--				

Course Objectives

1 Demonstrate advanced critical research skills in relation to career development or work-related learning studies.

2 Acquire the skills to publish the data in reputed journals, conference proceeding and workshops.

3 Demonstrate an ability to present and defend their research work to a panel of experts.

Course Outcomes

On completion of this course, the students will be able to

CO1 Know the concept, scope of research.

CO2 Enable the students to gain knowledge on particular areas of research.

CO3 Understand the scientific methods to study region.

CO4 Analyse the practical knowledge of research and apply the subject matter knowledge in the field.

CO5 Learn the art of reporting.

CO6 Able to educate the technical skill of writing.

Catalog Description

The objective of research project is to enable the student with hands-on experiences with learning to lead a research work. Research gives them experience based and active learning. It engages students with contexts, including the social and civic. The mentoring and collaboration dimensions of postgraduate research can foster ownership for commitment to high standards and accountability. While the research process in a discipline may be well-established, research always requires creativity, as well as patience and resolve in grappling with what sometimes feels ambiguous to all participants, including the faculty mentor. These features create opportunities for students to explore their own learning styles as well as develop exposure to those of others.

Guidelines

1. Students will be divided among faculty members of the School for the supervision of the research work.
2. In the first week of Semester III, each faculty member will assign a suitable research topic to the students from the selected topics in the areas of mathematical sciences.

3. The student will work on the assigned research topic during semesters III and IV in regular consultation with his/her assigned faculty member.
4. The student will write a dissertation based on the research work carried out during Semesters III and IV and prepare two copies to be submitted to the office of the Dean of the School duly signed by the student and the supervisor in the sixth week of IV semester or a date decided by the Dean of the Schoo.
5. Before preparing power point presentation and submission of dissertation, each student has to deliver a seminar talk on his/ her research project work on a date fixed by HOD, necessary suggestions have to be incorporated in the final draft of dissertation.
6. The student will make a power point presentation based on the work carried out and mentioned in the dissertation to the board of examiners appointed by the University.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	10	10	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	Mapped Program Outcomes
CO1	Know the concept, scope of research.	PO6
CO2	Enable the students to gain knowledge on particular areas of research.	PO1
CO3	Understand the scientific methods to study region.	PO8
CO4	Analyse the practical knowledge of research and apply the subject matter knowledge in the field	PO3
CO5	Learn the art of reporting.	PO9
CO6	Able to educate the technical skill of writing.	PO4

		Encourage critical thinking to conduct scientific investigations in a biased manner without prejudiced assumptions.	Assist students in analyzing questions, formulating hypotheses, evaluating and validating findings, and drawing logical conclusions.	Prepare students for pursuing research or careers and to design methods to conduct investigations of complex societal and environmental issues.	Continue to acquire relevant knowledge and skills to evaluate the concepts and scientific developments to take up any challenge.	Enhance knowledge mobilization through increased application of mathematics.	Able to use the advance knowledge in consultancy to solve real life problems.	Learn the subject with curiosity to understand new scientific developments.	Understand international perspective about mathematics.	Capability to use appropriate software's to solve mathematical equations.	Develop the protocols as per laboratory standards to accomplish the objectives.	Develop aptitude to formulate concepts based on fundamental axioms of mathematics.	Innovate, invent and solve complex mathematical problems using the knowledge of pure and applied mathematics.	Understand demands of the growing field of Mathematics by lifelong learning.	Develop problem-solving skills, critical thinking, and interest through assignments and project work	Prepare students for competitive examinations such as NET, GATE, and many others.
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
BSMA852A	Dissertation	3		3	2		3		3	3			3	3		

1=weakly mapped

2= moderately mapped

3=strongly mapped

Programme and Course Mapping																	
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	**2**											**3**	**2**	**1**	**1**	**2**	**2**
CO2								**2**				**3**	**2**	**1**	**1**	**2**	**2**
CO3					**3**							**3**	**2**	**1**	**1**	**2**	**2**
CO4		**2**										**3**	**2**	**1**	**1**	**2**	**2**
CO5			**3**									**3**	**2**	**1**	**1**	**2**	**2**
CO6	**3**											**3**	**2**	**1**	**1**	**2**	**2**
1=lightly mapped 2= moderately mapped 3=strongly mapped																	

	Dissertation
Local	-
Regional	-
National	-
Global	-
Employability	Choice Based Credit System having field projects / research projects / internships (1.3.4) Courses on employability/ entrepreneurship/ skill development (1.1.3); Student centric methods, such as experiential learning, participative learning and problem-solving methodologies (2.3.1)
Entrepreneurship	Entrepreneurship; Team work/ Creativity by designing research problem
Skill Development	Disciplinary knowledge; Research related skills; scientific skills,
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
SDG	Equal Access to TVET and Higher Education (SDG 4.3), Quality Education and skills for employability 4.4
NEP	Higher Education System through scientific temper (9.1.1) India's Higher Education System through scientific temper (9.1.1)Towards a More Holistic and Multidisciplinary Education opportunitiesfor cross-disciplinary and interdisciplinary thinking (11.6); strong culture of research and knowledge creation (17.6) "
POE/4th IR	Employability, Project, Hands on Experience, Entrepreneurship; Team work