JECRC UNIVERSITY

BUILD YOUR WORLD

Department of Mathematics

Course Structure and Syllabi

M.Sc. Mathematics Course

Session 2020-22

Faculty of Science

M.Sc. In Mathematics

M.Sc. Mathematics Scheme 2020-22

Total credits for the batch 2020-22 is 112

1. **Minimum credit required =101Credits.**
2. **Total relaxation = 11Credits.**
3. **No relaxation in core and foundation papers.**
4. **Option can be availed in specialization, interdisciplinary and general subjects.**

Summary Sheet

Semester	1^{st}	2^{nd}	3^{rd}	4^{th}	Total
Credits	28	26	28	30	112

Type	Total Credit
Foundation	20
Core	42
Specialization (Including Elective Papers)	66
Interdisciplinary	16
General	0

Semester I

	Subject	Paper Type	Subject Code	L	T	P	Credits (Total 28)
Theory	**Algebra-1**	**F**	**MMA001A**	3	1	0	4
	Advanced Analysis	**F**	**MMA002B**	3	1	0	4
	Topology	**F**	**MMA003A**	3	1	0	4
	Riemannian Geometry and Tensor Analysis	**F**	**MMA004A**	3	1	0	4
	Complex Analysis	**F**	**MMA005B**	3	1	0	4
Practical	**Scilab I**	**S**	**MMA030A**			4	4
	Numerical Analysis LAB I	**S**	**MMA031A**			4	4

Semester II

	Subject	Paper Type	Subject Code	L	T	P	Credits (Total 26)
Theory	**Algebra-II**	**C**	**MMA006A**	3	1	0	4
	Functional Analysis-I	**C**	**MMA007B**	3	1	0	4
	Analytic Dynamics	**ID**	**MMA008B**	3	1	0	4
	Calculus of Variation and Special Function	**C**	**MMA009A**	3	1	0	4
	Theory of Optimization	**C**	**MMA010B**	3	1	0	4
	Seminar	**S**	**MMA028A**				2
Practical	**Scilab II**	**S**	**MMA032A**			4	4

Semester III

	Subject	Paper Type	Subject Code	L	T	P	Credits (Total 28)
Theory	Differential Equations	S	MMA011B	3	1	0	4
	Functional Analysis-II	C	MMA012B	3	1	0	4
	Numerical Analysis	C	MMA013A	3	1	0	4
ELECTIVES (Any two of the following)							
Theory	Mathematical Modeling	ID	MMA014A	3	1	0	4
	Operations Research	C	MMA015B	3	1	0	4
	Discrete Mathematics	ID	MMA016A	3	1	0	4
	Fluid Dynamics	S	MMA017B	3	1	0	4
	Integral Equations	S	MMA018A	3	1	0	4
	Stochastic Processes & Queuing Theory	S	MMA036A	3	1	0	4
Practical	Latex LAB	S	MMA033A			4	4
	Numerical analysis LAB II	S	MMA034A			4	4

Semester IV

	Subject	Paper Type	Subject Code	L	T	P	Credits (Total 30)
Theory	**Integral Transforms**	**ID**	**MMA019A**	3	1	0	4
ELECTIVE (Any three of the following)*							
Theory	**Fractional Calculus**	**S**	**MMA020B**	3	1	0	4
	Hydrodynamics	**S**	**MMA021A**	3	1	0	4
	Numerical Solution of Partial Differential Equations	**S**	**MMA022A**	3	1	0	4
	Number Theory and Cryptography	**S**	**MMA023A**	3	1	0	4
	Fuzzy Sets and Applications	**S**	**MMA024A**	3	1	0	4
	Advanced Graph Theory	**S**	**MMA025A**	3	1	0	4
	Sampling Distribution & Testing of Hypothesis	**S**	**MMA026B**	3	1	0	4
	Non-linear Dynamical Systems	**S**	**MMA027A**	3	1	0	4
	Major Project (Dissertation)	**C**	**MMA029A**				10
Practical	**Latex beamer LAB**	**S**	**MMA035A**			4	4

*More Elective papers can be added subject to the availability of subject experts.

C-Core **F-Foundation**

S-Specialization **ID- Interdisciplinary**

G-General

SWAYAM is a programme initiated by Government of India and designed to achieve the three cardinal principles of Education Policy viz., access, equity and quality. The objective of this effort is to take the best teaching learning resources to all, including the most disadvantaged. SWAYAM seeks to bridge the digital divide for students who have hitherto remained untouched by the digital revolution and have not been able to join the mainstream of the knowledge economy.

Student can choose following subjects from "Swayam Portal" for fulfillment of their credits in the semester (depending upon the availability of the course on Swayam Portal).

1. **Operation Research**
2. **Functional Analysis**

Note:

1. The maximum number of students taking an elective shall be 35(preferably).
2. The electives will be offered to the students through counselling in thedepartment based on the marks obtained in the first twosemesters.

Break-up of practical mark allotment (of 35 marks)
Practical Record: 5 marks
Actual practicals: 20 marks
Question bank answers: 5 marks
(Spiral bound book with the answers in the candidates own handwriting) Viva: 5 marks

Break-up of internal assessment marks for theory (of 20 marks)
Attendance: 5 marks
Assignment: 15 marks

Break-up of internal assessment marks for practical (of 15 marks)

Preparatory practical exam or two internal tests: 15 marks

Break-up of project work mark allotment (of 70 marks)
ProjectReport : 10 marks
Actualproject : 40 marks
Question bank answers : 10marks
(Spiral bound book with the answers in the candidates own handwriting) Viva
: 10 marks

Objectives

Our Master of Science program is a versatile degree that provides students with the optimal balance between a defined sequence of study and flexible course options.

Mathematics is one of the most enduring fields of study, and is essential in an expanding number of disciplines and professions. Our unique program will help you combine your knowledge of mathematics and solve problems in the physical and biological sciences, engineering, information technology, economics, and business. You will learn study essential topicsincalculus,linearalgebraanddifferentialequationsthatcanbeapplieddirectlytobuild applications in coding and cryptology, mathematical physics, mathematical biology, bioinformatics andfinance.

The M.Sc. course in Mathematics aims at developing mathematical ability in students with acute and abstract reasoning. The course will enable students to cultivate a mathematician's habit of thought and reasoning and will enlighten students with mathematical ideas relevant for oneself and for the course itself.

MISSION AND VISION OF THE NEW SYLLABUS IN MATHEMATICS

Mission

- Improve retention of mathematical concepts in thestudent.
- To develop a spirit of inquiry in thestudent.
- To improve the perspective of students on mathematics as per modernrequirement.
- To initiate students to enjoy mathematics, pose and solve meaningful problems, to use abstraction to perceive relationships and structure and to understand the basic structure ofmathematics.
- To enable the teacher to demonstrate, explain and reinforce abstract mathematical ideas by using concrete objects, models, charts, graphs, pictures, posters with thehelp of software tools on acomputer.
- To make the learning process student-friendly by having a shift in focus in mathematical teaching, especially in the mathematical learning environment.
- Exploit techno-savvy nature in the student to overcomemath-phobia.
- To setup a mathematics laboratory in every college in order to help students in the exploration of mathematical concepts through activities andexperimentation.
- To orient students towards relating Mathematics toapplications.

Vision

- To remedy Math phobia through authentic learning based on hands-on experience withcomputers.
- To foster experimental, problem-oriented and discovery learning ofmathematics.
- To prove that the activity-center mathematics laboratory places the student in a problem solving situation and then through self-exploration and discovery habituates the student into providing a solution to the problem based on his or her experience, needs, andinterests.
- To provide greater scope for individual participation in the process of learning and becoming autonomouslearners.
- To provide scope for greater involvement of both the mind and the hand which facilitatescognition.
- To ultimately see that the learning of mathematics becomes more alive, vibrant, relevant and meaningful; a program that paves the way to seek and understand the world around them. A possible by-product of such an exercise is that math-phobiacan be gradually reduced amongststudents.
- To help the student build interest and confidence in learning thesubject.

<u>Program Specific Outcome:</u> M.Sc. Mathematics program:

PSO1: The Post graduates will become successful professionals by demonstrating logical and analytical thinking abilities (Professional Skills).

PSO2: The Post graduates will work and communicate effectively in inter-disciplinary environment, either independently or in a team, and demonstrate leadership qualities (Problem-Solving Skills).

PSO3: The Post graduates will engage in life-long learning and professional development through self-study, continuing education or professional and doctoral level studies (Successful Career andEntrepreneurship).

<u>Program Outcome(PO's)</u>

Upon completion of the **M.Sc.** Mathematics program, students will be able to:

PO1. Solve complex problems by critical understanding, analysis andsynthesis.

PO2. Demonstrate engagement with current research and developments in thesubject.

PO3. Evaluate hypotheses, theories, methods and evidence within their propercontexts.

PO4. Select, interpret and critically evaluate information from a range of sources that include books, scientific reports, journals, case studies and theinternet.

PO5. Provide a systematic understanding of the concepts and theories of mathematics and their application in the real world to an advanced level, and enhance career prospects in a huge array offields.

PO6. Demonstrate a range of appropriate general skills including ITcompetency.

PO7. Critically interpret data, write reports and apply the basics of rules ofevidence.

SEMESTER- I

MMA001A	Algebra-1	3-1-0 [4]

OBJECTIVE:

- To understand the advanced group theory.
- To understand field extension for metric tensors, Sylow's theorems and Galois theory.
- To develop an understanding of advanced areas inalgebra.

UNIT 1	Conjugate element, Normalizer, The class equation, Cauchy`s theorem for finite abelian group, Sylow *p*-subgroups.
UNIT 2	Direct product of groups. Structure theorem for finitely generated abelian groups.
UNIT 3	Normal and subnormal series. Composition series, Maximal subgroups, Jordan-Holder theorem. Solvable groups. Insolvability of Sn for $n \geq 5$.
UNIT 4	Extension fields. Finite, algebraic, and transcendental extensions, Splitting fields. Simple and normal extensions.
UNIT 5	Perfect fields, Primitive elements, Algebraically closed fields. Automorphisms of extensions. Galois extensions, Fundamental theoremof Galois theory, Galois group over the rationales.

Suggested Readings

1. N. Herstein, Topics in Algebra, Wiley Eastern,1975.
2. P. B. Bhattacharya, S. K. Jain and S. R. Nagpal, Basic Abstract Algebra (2nd Edition), Cambridge University Press, Indian Edition1977.
3. Ramji Lal, Algebra, Vol.1, Shail Publications, Allahabad 2001.
4. VivekSahai and VikasBist, Algebra, Narosa Publishing House1999.
5. D. S. Malik, J. N. Mordeson, and M. K. Sen, Fundamentals of Abstract Algebra, McGraw-Hill International Edition,1997.

Course Outcomes

CO1:- Understanding the basic concept of Conjugate element, Normalizer, the class equation, Cauchy`s theorem for finite abelian group, Sylow*p*-subgroups.
CO2:- Understanding the Structure theorem for finitely generated abelian groups.
CO3:- Understanding the basics concepts of normal, subnormal series and solvable groups.
CO4:- Understanding the basic concept of extension of fields.
CO5:- Developing the ability to understand Galois extensions, Fundamental theorem of Galois theory, Galois group over the rationales.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Outcome	Program Outcome							Program Specific Outcome		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	H		L					L	L	H
CO2	M		L		L			L	L	H
CO3	H	L	M	L	H			M	L	M
CO4	M	L	M	L	H	L	L	M	L	M
CO5	H	H	M	M	L	L	L	M	L	M

H = Highly Related; M = Medium; L = Low

MMA002B	Advanced Analysis	3-1-0 [4]

OBJECTIVE:

- To introduce students to Basic concept of Real Analysis.
- To focus on basic mathematical concepts in measurable functions.
- To focus on theoretical and mathematical concepts in Lebesgue integral and summable functions.
- To develop an understanding of real analysis.

UNIT 1	Functions of several variables, Derivative of functions in an open subset of $\mathbb{R}^n$ into $\mathbb{R}^m$ as a linear transformation, Chain rule, Partial derivatives
UNIT 2	Algebra and algebras of sets, Algebras generated by a class of subsets, Borel sets, Lebesgue measure of sets of real numbers, Measurability and Measure of a set, Existence of Non-measurable sets.
UNIT 3	Measurable functions, Realization of non-negative measurable function as limit of an increasing sequence of simple functions, Structure of measurable functions, Convergence in measure, Egoroff's theorem.
UNIT 4	Weierstrass's theorem on the approximation of continuous function by polynomials, Lebesgue integral of bounded measurable functions, Lebesgue theorem on the passage to the limit under the integral sign for bounded measurable functions.
UNIT 5	Summable functions, Space of square summable functions. Fourier series and coefficients, Parseval's identity, Riesz-Fisher Theorem.

Text Books:

1. Walter Rudin, Principle of Mathematical Analysis (3rd edition) McGraw-Hill Kogakusha, International Student Edition,1976.

Reference Books:

1. H. L., Royden, Real Analysis, 4th Edition, Macmillan,1993.
2. E. Hewitt and K. Stromberg, Real and Abstract Analysis, Springer, 1969

Course Outcomes:

CO1:- Understanding the basics concepts of Derivative of functions.
CO2:- Understanding the basics concepts of Lebesgue measure.
CO3:- Understanding the basics concepts of Measurable functions.
CO4:- Understanding the fundamental concept of Lebesgue integral.
CO5:- Developing the ability to understand summable functions.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Outcome	Program Outcome							Program Specific Outcome		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	H	M	L	L	M	L		H	H	M
CO2	H	M		M	H			H	M	M
CO3	M	M	L	M	H		L	M	H	M
CO4	H	M	L	M	L			M	H	M
CO5	H	H	M	M	L	L		H	M	M

H = Highly Related; M = Medium L = Low

MMA003A	Topology	3-1-0 [4]

OBJECTIVE:

- To explain how to distinguish spaces by means of simple topological invariants compactness, connectedness and the fundamental group.
- To explain how to construct spaces by gluing and to prove that in certain cases that the result is homeomorphic to a standardspace.
- To construct simple examples of spaces with given properties e.g. compact but not connected or connected but not pathconnected.

Unit 1	Topological Space; Definition and examples of topological spaces. Closed sets. Closure. Dense sets. Neighborhood, interior, exterior, and boundary. Accumulation points and derived sets. Bases and sub-bases. Subspaces and relative topology.
Unit2	Continuous functions and homeomorphism. First and second countable space. Lindelof spaces. Alternative methods of defining a topology in terms of Kuratowski closure operator and neighborhood systems.
Unit 3	Separable spaces. The separation axioms *T0*, *T1*, *T2*, *T3½*, *T4*; their characterizations and basic properties. Urysohn's lemma. Tietze extension theorem.
Unit 4	Compactness. Basic properties of compactness. Compactness and finite intersection property. Sequential, countable, and B-W compactness. Local compactness. One-point compactification. Connected spaces and theirbasic properties. Connectedness of the real line.
Unit 5	Components. Locally connected spaces. Tychonoff product topology in terms of standard sub-base and its characterizations. Product topology and separation axioms, connectedness, 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.

Suggested Readings

1. J. L. Kelley, General Topology, Van Nostrand,1995.
2. K. D. Joshi, Introduction to General Topology, Wiley Eastern,1983.

3. James R. Munkres, Topology, 2nd Edition, Pearson International,2000.
4. J. Dugundji, Topology, Prentice-Hall of India, 1966.
5. George F. Simmons, Introduction to Topology and Modern Analysis, McGraw-Hill, 1963.
6. N. Bourbaki, General Topology, Part I, Addison-Wesley,1966.
7. S. Willard, General Topology, Addison-Wesley,1970.
8. S.W. Davis Topology, Tata McGraw Hill,2006.

Course Outcomes

CO1:- Understanding the Topological spaces and their properties.
CO2:- Understanding the basics concepts of First and second countable space over deferent spaces.
CO3:- Understanding the basics concepts of Separable spaces.
CO4:- Understanding the compact spaces and connected spaces and their basic properties
CO5:- Developing the ability to understand Nets and filters and their convergence
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MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Outcome	Program Outcome							Program Specific Outcome		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	L		M			H		L	M	H
CO2		L		M	M			M	M	H
CO3		L	L	M	H			L	L	M
CO4		M	M	L	H	L			M	M
CO5	H	H	M	M	L		L	M	L	H

H = Highly Related; M = Medium; L = Low

MMA004A	Riemannian Geometry and Tensor Analysis	3-1-0 [4]

OBJECTIVE:

- To understand the Transformation rules from Cartesian coordinates to curvilinear coordinates.
- To describe methods for metric tensors, Cristoffel symbols, curl, divergence, gradient of tensors calculations.
- To develop an understanding of Riemanniangeometry.

UNIT 1	Geodesics, Differential equation of a geodesic, Single differential equation of a geodesic, Geodesic on a surface of revolution, Geodesic curvature and torsion, Gauss-Bonnet Theorem.
UNIT 2	Tensor Analysis– Coordinates, vectors, Tensors, Transformation of coordinates, Kronecker delta. Contra-variant and Covariant tensors, Symmetric tensors, Fundamental operations with tensors, Quotient law of tensors, Relative tensor.
UNIT 3	Riemannian space. Metric tensor, Indicator, Associate tensors, Length of a curve, Magnitude of a vector, unit vector, Null vector, Angle between two non-null vectors, Permutation symbols and Permutation tensors.
UNIT 4	Christoffel symbols and their properties, Covariant differentiation of tensors. Ricci's theorem, Intrinsic derivative, Geodesics, Differential equation of geodesic, Geodesic coordinates, Fieldof parallel vectors.
UNIT 5	Reimann-Christoffel tensor and its properties. Co-variant curvature tensor, Einstein space. Bianchi's identity. Einstein tensor, Flat space, Isotropic point, Schur's theorem.

Suggested Readings

1. R. S. Mishra, A Course in Tensors with Applications to Riemanian Geometry, Pothishala,Allahabad,1965.
2. Y. Matsushima, Differentiable Manifolds, Marcel Dekker,1972.
3. B. B. Sinha, An Introduction to Modern Differential Geometry, KalyaniPrakashan, New Delhi,1982.
4. Y. Talpiert, Differential Geometry with applications to Mechanics and Physics, Marcel DekkarInc.2001.
5. N.J. Hicks, Notes on Differential Geometry, D. Van Nostrand Inc.,1965.
6. Bansal, J.L. and Sharma, P.R., Differential Geometry: Jaipur Publishing House (2004).
7. Bansal, J.L., Tensor Analysis, Jaipur Publishing House,(2004).

<u>CourseOutcomes</u>

CO1:-Understanding the difference between Cartesian coordinates and curvilinear coordinates.

CO2:-Understanding the basics concepts of Tensors and its components.

CO3:- Understanding the basics concepts of Riemann space metric.

CO4:-Understanding the various techniques to calculate Christoffel symbols, Covariant differentiation oftensors.

CO5:-Developing the ability to understand Einstein space, Bianchi's identity.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Outcome	Program Outcome							Program Specific Outcome		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1		L	H		M			L	M	H
CO2			L	M	H			M	M	H
CO3		L	L	M	H			L	L	M
CO4		M	M	L	H	L			M	M
CO5	H	H	M	M	L		L	M	L	H

H = Highly Related; M = Medium; L = Low

MMA005B	Complex Analysis	3-1-0 [4]

OBJECTIVE:

- To understand the concept of analytic functions, varieties of operations, analyses and problems that may arise within the context of a complex variable
- To study power series and the useful techniques for evaluating contour integrals based on the 'calculus of residues'
- To understand the complex mapping with their applications.

UNIT 1	**Analytic functions**: Introduction. Cauchy Riemann's equations. Complex Integration. Cauchy–Goursat Theorem, Proof of the Theorem ,Simply Connected Domains ,Multiply Connected Domains, Cauchy Integral Formula ,An Extension of the Cauchy Integral Formula, Some Consequences of the Extension, Liouville's Theorem and the Fundamental Theorem of Algebra. Maximum Modulus Principle.
UNIT 2	**Series**: Convergence of Sequences ,Convergence of Series, Taylor Series, Proof of Taylor's Theorem, Laurent Series, Proof of Laurent's Theorem, Absolute and Uniform Convergence of Power Series **Residues and Poles**: Isolated Singular Points, Residues, Cauchy's Residue Theorem, Residue at Infinity, The Three Types of Isolated Singular Points ,Residues at Poles, Zeros of Analytic Functions, Zeros and Poles, Behavior of Functions Near Isolated Singular Points.
UNIT 3	**Application of Residues**: Evaluation of Improper Integrals, Improper Integrals from Fourier Analysis, Jordan's Lemma, Indented Paths, Definite Integrals Involving Sines and Cosines, Argument Principle, Rouch´e's Theorem.
UNIT 4	**Mapping by Elementary Functions**: Linear Transformations ,Linear Fractional Transformations, Mappings of the Upper Half Plane ,Riemann Surfaces **Conformal Mapping, Applications of Conformal Mapping**: Steady Temperatures, Steady Temperatures in a Half Plane, Temperatures in a Quadrant, Electrostatic Potential, Potential in a Cylindrical Space .The Bilinear or Fractional Transformation, The Schwarz–Christoffel Transformation.
UNIT 5	Analytic continuation. Schwarz's Reflection Principle, Infinite Products, Absolute, Conditional and Uniform Convergence of Infinite Products, Some Important Theorems on Infinite Products, Weierstrass' Theorem for Infinite Products, Some Special Infinite Products.

Suggested Readings

1. Brown and Churchill, Complex Variables and Applications, McGraw-Hill Education; 9 edition, 2013
2. Schaum's Outline of Complex Variables, 2ed (Schaum's Outlines) 2nd Edition
3. E. C. Titchmarsh, The Theory of Functions, Oxford UniversityPress,1990.
4. J. B. Conway, Functions of One Complex Variable, Narosa Publishing House,1980.
5. E. T. Copson, Complex Variables, Oxford UniversityPress,1998.
6. L. V. Ahlfors, Complex Analysis, McGraw-Hill,1977.
7. D. Sarason, Complex Function Theory, Hindustan Book Agency, Delhi,1994.

Course Outcomes:

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

CO1 Understand the significance of Cauchy-Riemann equations for analytic function. Differentiability for complex functions and be familiar with the Cauchy-Riemann equations. Will able to evaluate integrals along a path in the complex plane.

CO2 Able to compute the Taylor and Laurent expansions of simple complex functions. Determine the nature of the singularities and calculating residues.

CO3 Will able to solve improper integrals of various types.

CO4 Understand the concept of complex mapping

CO5 Able to identify analytic continuation with their related problems

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Outcome	**Program Outcome**							**Program Specific Outcome**		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	H	H	M				M	H	M	L
CO2	H	M	L				M	M	H	M
CO3	H	L	L				M	H	L	L
CO4	H	M	L				M	M	M	L
CO5	H	M	M				L	M	H	L

H = Highly Related; M = Medium; L = Low

MMA030A	Scilab I	0-0-4 [4]

OBJECTIVE:

- This course can be used by students in Mathematics as an introduction to the fundamental ideas of SCILAB PACKAGE and as a foundation for the development of more advanced concepts inSCILAB.
- Study of this course promotes the development of basic programming skills in SCILAB and some basic introduction of MAXIMAsoftware.

List of programs

1. Introduction to Scilab and commands connected withmatrices.
2. Computations withmatrices.
3. Solving system of equation and explainconsistence.
4. Find the values of some standard trigonometric functions in radians as well as indegree.
5. Create polynomials of different degrees and hence find its real roots.
6. Find $\sum_{n=1}^{500} n$ using loopingstructure.
7. Display Fibonacci series using Scilab program.
8. Display non-Fibonacci series using Scilab program.
9. Introduction to Maxima and matrices computations.
10. Commands for derivatives and n^{th} derivatives.
11. Scilab and Maxima commands for plotting functions.

TEXT BOOKS/OPEN SOURCE MATERIALS

1. http://maxima.sourceforge.net/docs/intromax/intromax.pdf
2. www.scilab.org.
3. Wxmaxima.sourceforge.net

Course Outcomes (COs):

Upon successful completion of this subject students should be able to:

CO1: Understand the main features and importance of the SCI LAB mathematical programming environment

CO2: Apply working knowledge of SCI LAB package to simulate and solve matrices, system of equations, trigonometric functions, Fibonacci series and applications.

CO3: Solve, simulate and analyze various matrices.

CO4: Solve, simulate and analyze various system of equations.

CO5: Solve, simulate and analyze trigonometric functions, Fibonacci series.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Outcome	**Program Outcome**							Program Specific Outcome		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	H							L	M	L
CO2		H						H	H	M
CO3					H	M		L	M	H
CO4		H					H	H	M	M
CO5								H	H	H

H = Highly Related; M = Medium; L = Low

MMA031A	Numerical Analysis I	0-0-4 [4]

OBJECTIVE:

- This course can be used by students in Mathematics as an introduction to the fundamental ideas of numerical analysis on SCILABPACKAGE.

List of programs:

1. Introduction to Scilab – 2 weeks
2. Fixed Point iterative method
3. Newton-Raphson's method
4. Ramanujan's method
5. Gauss Eliminationmethod
6. Gauss-Seidel iterative method
7. Thomas Algorithm
8. Lagrange Interpolation method
9. Cubic Spline Interpolation method
10. Rational function approximation of Pade Numerical integration over rectangularregion
11. Gaussian Quadrature method
12. Gauss-Chebyshev method

TEXT BOOKS/ OPEN SOURCE MATERIALS

1. M.K. Jain: Numerical solution of differential equations, Wiley Eastern (1979), Second Edition.
2. C.F. Gerald and P.O. Wheatley: Applied Numerical Methods, Low- priced edition, Pearson Education Asia (2002), Sixth Edition.
3. D.V. Griffiths and I.M. Smith, Numerical Methods for Engineers, Blackwell Scientific Publications (1991).
4. www.scilab.org

REFERENCE BOOKS

1. S.C. Chapra, and P.C. Raymond: Numerical Methods for Engineers, Tata Mc Graw Hill, New Delhi(2000).
2. R.L. Burden, and J. Douglas Faires: Numerical Analysis, P.W.S. Kent Publishing Company, Boston (1989), Fourthedition.
3. S.S. Sastry: Introductory methods of Numerical analysis, Prentice- Hall of India, New Delhi(1998).
4. M.K. Jain, S.R.K. Iyengar and R.K. Jain: Numerical methods for scientific and Engineering computation, Wiley Eastern(1993).
5. G.D. Smith: Numerical Solutions of partial differential equations 2nd edition London, Oxford University Press(1978).
6. ParuizMoin: Fundamentals of Engineering Numerical analysis, Cambridge University Press(2006).
7. SCILAB- A Free software to MATLAB by Er. Hema Ramachandran and Dr. Achuthsankar
8. S. Nair., S. Chand and Company Ltd.(2008)

Course Outcomes (COs):

Upon successful completion of this subject students should be able to:

CO1: Understand the main features and importance of the SCI LAB mathematical programming environment.

CO2: Solution of equations: Newton-Raphson’s method, Ramanujan’s method, Gauss Elimination method, Gauss Elimination method and Gauss-Seidel iterative method(Using SCI LAB).

CO3: Interpolation: Cubic spline interpolation (Using SCI LAB).

CO4: Numerical integration: Rational function approximation of Pade Numerical integration over rectangular region (Using SCI LAB).

CO5: Gaussian Quadrature method and Gauss-Chebyshevmethod (Using SCI LAB).

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Outcome	**Program Outcome**							Program Specific Outcome		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	H							H	M	H
CO2		H		M		M	H	L	L	M
CO3								L	M	L
CO4								M	M	M
CO5					H			L	L	L

H = Highly Related; M = Medium; L = Low

SEMESTER - II

MMA006A	Algebra-II	3-1-0 [4]

OBJECTIVE:

- To understand the advanced modulustheory.
- To understand advanced ring theory and Canonicalforms.
- To develop an understanding of advanced areas inalgebra.

UNIT 1	Modules, submodules, Quotient Modules, Isomorphism theorems.
UNIT 2	Cyclic modules, simple modules and semisimple modules and rings Schur's lemma. Free modules.
UNIT 3	Noetherian and Artinian modules and rings.
UNIT 4	Hilbert basis theorem. Solution of polynomial equations by radicals. Insolvability of the general equation of degree $\geq$ 5 by radicals.Finite fields.
UNIT 5	Canonical forms: Similarity of linear transformations. Invariant subspaces. Reduction to triangular forms. Nilpotent transformations. Index of nilpotency. Invariants of a nilpotent transformation. The primary decomposition theorem. Jordan blocks and Jordan form.

Suggested Readings

1. N. Herstein, Topics in Algebra, Wiley Eastern,1975.
2. P. B. Bhattacharya, S. K. Jain and S. R. Nagpaul, Basic Abstract Algebra (2nd Edition),CambridgeUniversity Press,1997.
3. K. Hoffman and R. Kunze, Linear Algebra, 2nd Edition, Prentice Hall of India,1971.
4. D. S. Malik, J. N. Mordeson, and M. K. Sen, Fundamentals of Abstract Algebra, McGraw- HillInternational Edition,1997.
5. VivekSahai and VikasBist, Algebra, Narosa Publishing House,1999.
6. Ramji Lal, Fundamentals in Abstract Algebra, Chakra Prakashan, Allahabad,1985.
7. J.S. Golan, Modules & the Structures of Rings, MarclDekkar.Inc.

Course Outcomes

CO1:-Understanding the basic concept of Modules, submodules, Quotient Modules, Isomorphism theorems.

CO2:-Understanding the cyclic modules, simple modules and semisimple modules, rings, Schur's lemma and free modules.

CO3:- Understanding the basics concepts of Noetherian, Artinian modules and rings.

CO4:-Understanding the basic theory of Hilbert basis theorem and solution of polynomial equations.

CO5:-Developing the ability to understand the Canonical form, Jordan blocks, Jordan form and transformations.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Outcome	Program Outcome							Program Specific Outcome		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	L		M		L			M	L	M
CO2	L		M		L			M	L	M
CO3	L	M	M	L	H		L	M	L	H
CO4	L	L	M	L	H		L	H	L	M
CO5	L		L		L	L		L	L	L

H = Highly Related; M = Medium; L = Low

MMA007B	Functional Analysis- I	3-1-0 [4]

OBJECTIVE:

- To introduce students to Basic concept of metric spaces.
- To develop an understanding of normed linear spaces and linear transformations.
- To develop an understanding few important applications of normed linear spaces analysis to other branches of both pure and applied mathematics.

UNIT 1	Metric Space, Subspace of a metric space, Product space, Continuous mappings, Sequence in a metric space, Convergence, Cauchy sequence. Complete metric space, Examples of Complete & Incomplete metric spaces.
UNIT 2	Banach contraction theorem and applications. Baire's category theorem, Ascoli-Arzela theorem, compact sets, compact spaces and connected metric spaces. Separable metric space with examples.
UNIT 3	Normed linear spaces. Quotient space of normed linear spaces and its completeness. Banach spaces and examples. Bounded linear transformations. Normed linear space of bounded linear transformations
UNIT 4	Equivalent norms. Basic properties of finite dimensional normed linear spaces and compactness. Reisz Lemma. Multilinear mapping. Open mapping theorem. Closed graph theorem. Uniform boundness theorem.
UNIT 5	Continuous linear functionals. Hahn-Banach theorem and its consequences. Embedding and Reflexivity of normed spaces. Dual spaces with examples. Inner product spaces.

Text Books:

1. Erwin Kreyszig, Introductory Functional Analysis with Applications, John Wileyand Sons (Asia). Pvt. Ltd. 2006.
2. George Bachman and Lawrence Narici, Functional Analysis, Dover,2000.

Reference Books:

1. Jchn B. Conway. A course in Functional Analysis, second edition, Springer-Verlag. 2006.
2. Martin Schechter, Principles of Functional Analysis, second edition. AMS Bookstore, 2002.
3. V.S. Sunder. Functional Analysis. Spectral Theory, Birkhauser Texts, Basel. 1997.

Course Outcomes:

CO1:- Understanding the basic concept of Metric Space, Subspace of a metric space, Convergence.

CO2:- Understanding the compact sets, compact spaces and connected metric spaces

CO3:- Understanding the Normed linear spaces

CO4:- Understanding the Reisz Lemma. Multilinear mapping. Open mapping theorem. Closed graph theorem. Uniform boundness theorem.

CO5:- Understanding the Continuous linear functionals. Hahn-Banach theorem and its consequences, Dual spaces with examples.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Outcome	Program Outcome							Program Specific Outcome		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	H	M	L	L	M	L		H	H	M
CO2	H	M		M	H			H	M	M
CO3	M	M	L	M	H		L	M	H	M
CO4	H	M	L	M	L			M	H	M
CO5	H	H	M	M	L	L		H	M	M

H = Highly Related; M = Medium; L = Low

MMA008B	Analytic Dynamics	3-1-0 [4]

OBJECTIVE:
- The mathematical framework plays a role in the formulation of modern quantum and relativity theories.
- Topics studied the kinematics of dynamics of systems of particles.
- Topics studied Lagrangian and Hamiltonian dynamics and rigid body dynamics.
- The emphasis is both on the formal development of the theory and also use of theory in solving actual physical problems.

Unit 1	Fundamental laws of mechanics. System of forces. Moment and Couples. Equilibrium, Conditions for equilibrium. Lami's theorem. Location of centroid and center of gravity.
Unit 2	Moment of inertia, Parallel axis theorem, Radius of gyration, M.I of composite section, M.I of solid bodies. D Alembert’s principle. The general equations of motion of a rigid body. Motion of center of inertia and motion relative to center of inertia.
Unit 3	Motion about a fixed axis. The compound pendulum, Centre of percussion. Motion of a rigid body in two dimensions under finite and impulsive forces. Motion in three dimensions with reference to Euler’s dynamical and geometrical equations. Motion under no forces, Motion under impulsive forces.
Unit 4	Conservation of momentum (linear and angular). Lagrange’s equations for holonomous dynamical system. Energy equation for conservative field. Small oscillations, Motion of a top
Unit 5	Hamilton’s equations of motion, Hamilton’s principle and principle of least action.

Suggested Readings:

1. N. C. Rana and P.S. Joag, Classical Mechanics, Tata McGraw-Hill, 1991.
2. J. L. Synge and B. A. Griffith, Principles of Mechanics, McGraw-Hill, 1991.
3. L. N. Hand and J. D. Finch, Analytical Mechanics, Cambridge University Press, 1998.
4. Naveen Kumar Generalized Motion of Rigid Body, Narosa, 2004.
5. S.L. Loney - An Elementary Treatise on the Dynamics of a Particle and of Rigid Bodies, Kalyani Publishers, New Delhi, 2004.
6. Bansal, J.L., Dynamics of a Rigid Body, Jaipur Publishing Co., 2004

Course Outcomes:

CO1:- Understanding the Fundamental laws of mechanics.
CO2:- Understanding the basics concepts of D Alembert’s principle.
CO3:- Understanding the basics concepts of Euler’s dynamical equation of motion.
CO4:- Understanding the Lagrange’s equation of motion.
CO5:- Developing the ability to understand Hamilton’s principle and principle of least action.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Outcome	Program Outcome							Program Specific Outcome		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1		L	M		L			L	M	L
CO2			L	M	H			H	H	H
CO3		L	M	H	L			L	L	M
CO4		M	M	L	H	L			M	M
CO5	M	H	H	M	L		L	M	L	H

H = Highly Related; M = Medium; L = Low

MMA009A	Calculus of Variation and Special Function	3-1-0 [4]

OBJECTIVE:

- To understand the basic variational problem and Euler's equation
- To determine types of DEs, which may be solved by application of specialfunctions.
- To analyze properties of special functions by their integral representations and symmetries.
- To classify differential equations by theirsingularities

UNIT 1	Calculus of variation – Functionals, Variation of a functional and its properties, Variation problems with fixed boundaries, Euler's equation, Extremals, Functional dependent on several unknown functions and their first order derivatives. Functionals dependent on higher order derivatives, Functionals dependent on the function of more than one independent variable. Variational problems in parametric form.
UNIT 2	Gauss hypergeometric function and its properties, Series solution of Gauss hypergeometric equation. Integral representation, Linear and quadratic transformation formulas, Contiguous function relations, Differentiation formulae.
UNIT 3	Linear relation between the solutions of Gauss hypergeometric equation, Kummer's confluent hypergeometric function and its properties, Integral representation, Kummer's first transformation and
UNIT 4	Series solution of Legendre's equation, Legendre polynomials and functions Pn(x) and Qn(x).Besselfunctions Jn(x). Properties of Pn(x) and Qn(x).
UNIT 5	Hermite polynomials Hn(x), Laguerre and Associated Laguerre polynomials.

Suggested Readings

1. A.S. Gupta. Calculus of Variation, Prentice Hall of India Pvt. Ltd,2002.
2. I.M.Gelfand and S. V. Francis. Calculus of Variation, Prentice Hall, NewJersey.
3. Rainiville, E.D. Special Functions. Macmillan & Co. New York(1960).
4. Labedev, W.N. Special Functions and their Applications. Dover,(1972).

Course Outcomes

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

CO1 Students will be able to formulate variational problems and analyze them to deduce key properties of systembehavior.

CO2 Will able to identify Gauss hypergeometric function with it's solution and integral representation

CO3 Derive the properties of Gauss hypergeometric function (such as recursion relations, derivative relationships, and orthogonality conditions)etc.

CO4 Understand Bessel's and Legendre's equation with it's solution and various properties.

CO5 Understand Hermite's polynomial and Laguerre's equation with it's solution and variousproperties

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Outcome	Program Outcome							Program Specific Outcome		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	H	H	M				M	H	M	L
CO2	H	M	L				M	M	H	M
CO3	H	L	L				M	H	L	L
CO4	H	M	L				M	M	M	L
CO5	H	M	M				L	M	H	L

H = Highly Related; M = Medium; L = Low

MMA010B	Theory of Optimization	3-1-0 [4]

OBJECTIVE:

This course is designed to introduce basic optimization techniques in order to get best results from a set of several possible solutions of different problems viz.

- Linear programming problems,
- Transportation problem,
- Assignment problem and unconstrained and
- Constrained problems etc.
- The major focus will be on formulation of real world phenomena from its physical considerations and implementation of optimization algorithms for solving these problems.

UNIT 1	Formulation of linear programming problem (LPP) -graphical method, Basic Feasible Solution, Extreme Points, Convex set, Convex linear combination, optimal solution of LPP using Simplex, BigM and two-phase methods, Exceptional cases in LPP i.e., Infeasible, unbounded, alternate and degenerate solutions.
UNIT 2	General Primal-Dual pair, Formulating a dual problem, Weak and strong duality theorems, Complementary slackness theorem, Dual simplex method, Economic interpretation of primal-Dual problems. Sensitivity analysis: change in right hand side of constraints, change in the objective function and coefficient matrix addition and deletion of constraint and variables.
UNIT 3	Initial basic Feasible solution of transportation problem, Balanced and unbalanced transportation problems, Optimal solutions of transportation problem using U-V /MODI methods
UNIT 4	Assignment problems; Mathematical formulation of assignment problem, typical assignment problem, the traveling salesman problem, Test for optimality, degeneracy, Integer Programming Problem: Introduction, Types of Integer Programming Problems, Gomory's All-IPP Method, All IPP Algorithm, Branch and Bound Technique
UNIT 5	Concept of convexity and concavity, Maxima and minima of convex functions, Single and multivariate unconstrained problems, constrained programming problems, Kuhn-Tucker conditions for constrained programming problems.

Suggested Readings

1. Edwin K. P. P. Chong, Stanislaw H. Zak, An Introduction to Optimization, Johan Welly.
2. M. C. Joshi & K.M. Moudgalya, Optimization Theory & Practice, Narosa Publ. New Delhi 2004.
3. S.S.Rao, Engg. Optimization: Theory & Practice, New Age Intl. Pub. New Delhi, 2003.
4. Laurence, Fausett, Fundamentals of Neural Networks, Pearson education Ltd,2005.
5. D.E. Goldberg, Genetic Algorithms in neural optimization and machine learning, Pearson Education.Ltd.2004.
6. Sharma S. D., Operations Research: Theory, Methods & Applications, KEDAR NATH RAM NATH-MEERUT, 2011.
7. Kapoor V.K., Operations Research, Sultan Chand & Sons,2004.

Course Outcomes:

At the end of the course, the students will be able to

CO1 Apply the knowledge of basic optimization techniques in order to get best possible results from a set of several possible solution of different problems viz. linear programming problems, transportation problem, assignment problem and unconstrained and constrained problems etc.

CO2 Formulate an optimization problem from its physical consideration.

CO3 Select and implement an appropriate optimization technique keeping in mind its limitations in order to solve a particular optimization problem.

CO4 Understand theoretical foundation and implementation of similar type optimization techniques available in the scientific literature.

CO5 Continue to acquire knowledge and skills of optimization techniques that are appropriate to professional activities.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Outcome	Program Outcome							Program Specific Outcome		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1		L	H		M			L	M	H
CO2			L	M	H			M	M	H
CO3		L	L	M	H			L	L	M
CO4		M	M	L	H	L			M	M
CO5	H	H	M	M	L		L	M	L	H

H = Highly Related; M = Medium; L = Low

MMA032A	Scilab II	0-0-4 [4]

OBJECTIVE:

- This course can be used by students in Mathematics as an introduction to the fundamental ideas of advance numerical analysis on SCILAB PACKAGE and Plot graphs usingSCILAB.

List of Program:

1. Milne Predictor CorrectorMethod
2. Adam Moulton Predictor CorrectorMethod
3. Runge–Kutta–Fehlbergmethod
4. Finite difference method for BVP(ODE)
5. Finite difference method for Laplace/Poisson equations
6. Initial Boundary Value Problem using Explicit Finite DifferenceMethod
7. Schmidt Method
8. Crank-Nicolsonmethod
9. Crank Nicolson Scheme for DiffusionEquation
10. Shooting method for BVPsODE.
11. Explicit Finite difference method for 1-d waveequation
12. Galerkin Finite Element Methods for ODEBVPs

TEXT BOOKS

1. M.K. Jain: Numerical solution of differential equations, Wiley Eastern(1979),Second Edition.
2. C.F. Gerald and P.O. Wheatley: Applied Numerical Methods, Low- priced edition, Pearson Education Asia (2002), SixthEdition.
3. D.V. Griffiths and I.M. Smith, Numerical Methods for Engineers, Blackwell Scientific publications(1991).

REFERENCE BOOKS

1. S.C. Chapra, and P.C. Raymond: Numerical Methods for Engineers, Tata McGraw Hill, New Delhi(2000).
2. R.L. Burden, and J. Douglas Faires: Numerical Analysis, P.W.S. Kent Publishing Company, Boston (1989), Fourthedition.
3. S.S. Sastry: Introductory methods of Numerical analysis, Prentice- Hall of India, New Delhi(1998).
4. M.K. Jain, S.R.K. Iyengar and R.K. Jain: Numerical methods for scientific and Engineering computation, Wiley Eastern(1993)

Course Outcomes (COs):

Upon successful completion of this subject students should be able to:

CO1: Understand the main features and importance of the SCI LAB mathematical programming environment.

CO2: Apply working knowledge of SCI LAB package to simulate and solve ordinary differential equations.

CO3: Solution of ODE: Milne Predictor Corrector Method, Adam Moulton Predictor Corrector Method and Runge–Kutta–Fehlberg method (Using SCI Lab).

CO4: Solution of ODE: Finite difference method for Laplace/Poisson equations, Initial Boundary Value Problem using Explicit Finite Difference Method (Using SCI Lab).

CO5: Solution of 1-D wave equation and BVPs ODE: Shooting method, Explicit Finite difference method and Galerkin Finite Element Methods (Using SCI Lab).

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Outcome	**Program Outcome**							Program Specific Outcome		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1			M				H	L		H
CO2		H						H	M	L
CO3					H	M				M
CO4				M				M	H	
CO5				H					L	

H = Highly Related; M = Medium; L = Low

Semester –III

MMA011B	Differential Equations	3-1-0 [4]

OBJECTIVE:

- To develop an understanding of Non-linear ordinary differential equations of particular forms.
- To develop an understanding the series solution, radius of convergence and method of differentiation.
- To develop an understanding of Partial differential equations of second order with variable co-efficient.
- To develop an understanding of linear homogeneous boundary value problems.
- To develop an understanding of Non-homogeneous boundary value problems.

UNIT 1	Non-linear ordinary differential equations of particular forms. Riccati's equation –General solution and the solution when one, two or three particular solutions are known. Total Differential equations. Forms and solutions, necessary and sufficient condition, Geometrical Meaning Equation containing three and four variables, total differential equations of second degree.
UNIT 2	Series Solution: Radius of convergence, method of differentiation, Cauchy-Euler equation, Solution near a regular singular point (Method of Forbenius) for different cases, Particular integral and the point at infinity.
UNIT 3	Partial differential equations of second order with variable coefficients- Monge's method. Classification of linear partial differential equation of second order, Canonical forms, Cauchy's problem of first order partial differential equation.
UNIT 4	Linear homogeneous boundary value problem, Eigen values and eigen functions, Sturm-Liouville boundary value problems, orthogonality of eigen functions, Lagrange's identity, properties of eigen functions, important theorems of Sturm Liouville system, Periodic functions.
UNIT 5	Non-homogeneous boundary value problems, Non-homogeneous Sturm-Liouville boundary value problems (method of eigen function expansion). Method of separation of variables, Laplace, wave and diffusion equations. Green's Functions: Non-homogeneous Sturm-Liouville boundary value problem (method of Green's function), Procedure of constructing the Green's function and solution of boundary value problem, properties of Green's function, Inhomogeneous boundary conditions, Dirac delta function, Bilinear formula for Green's function, Modified Green's function.

Reference Books:

1. J.L. Bansal and H.S. Dhami, Differential Equations Vol-II, JPH, 2004.
2. M.D. Rai singhania, Ordinary and Partial Differential Equations, S. Chand & Co., 2003.
3. L. C. Evans, Partial Differential Equations, Graduate Studies in Mathematics, Vol. 19, AMS, 1999.
4. I.N. Sneddon, Elements of Partial Differential Equations, McGraw-Hill, 1988.
5. E.A. Codington, An Introduction to Ordinary Differential Equations, Prentice Hall of India, 1961.
6. Frank Ayres, Theory and Problems of Differential equations, TMH, 1990.
7. D.A. Murray, Introductory Course on Differential Equations, Orient Longman,1902.
8. A.R.Forsyth, A Treatise on Differential Equations, Macmillan & Co. Ltd., London, 1956.

Course Outcomes: At the end of the course, the student should be able to:

CO1:- Develop an understanding of Non-linear ordinary differential equations of particular forms.

CO2:- Develop an understanding the series solution, radius of convergence and method of differentiation.

CO3:- Develop an understanding of Partial differential equations of second order with variable co-efficient.

CO4:- Develop an understanding of linear homogeneous boundary value problems.

CO5:-Develop an understanding of Non-homogeneous boundary value problems.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Outcome	Program Outcome							Program Specific Outcome		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	H	L	L	L	M	M	M	H	M	H
CO2	L		M	L	M	M	H	L	L	H
CO3	H	H	M	H			M	M	H	M
CO4	H	M		L	M	L		H	M	H
CO5	H	H	M		L		H	H	H	L

H = Highly Related; M = Medium L = Low

MMA012B	Functional Analysis-II	3-1-0 [4]

OBJECTIVE:

- To introduce students to Basic concept of Hilbert space and its properties.
- To develop an understanding of Orthonormal sets and Hilbert space.
- To develop an understanding few important applications of Differential calculus in Banach Space and Integral Calculus in Banach Space.

UNIT 1	Hilbert space and its properties. Cauchy-Schwartz inequality, Orthogonality and Functionals in Hilbert Spaces. Phythagorean theorem, Projection theorem, Separable Hilbert spaces and Examples.
UNIT 2	Orthonormal sets, Bessel's inequality, Existence of orthonormal bases by Gram-schimidt orthogonalization process. Complete orthonormal sets, Parseval's identity, Structure of a Hilbert space, Riesz representation theorem, Reflexivity of Hilbert spaces.
UNIT 3	Adjoint of an operator on a Hilbert space. Self-adjoint, Positive, Normal and Unitary operators and their properties. Projection on a Hilbert space. Invariance. Reducibility. Orthogonal projections. Eigen values and eigen vectors of an operator. Spectrum of an operator Spectral theorem.
UNIT 4	Differential calculus in Banach Space, Differentiability of Mappings between Banach Space, Derivatives of a Composite Map, Directional Derivative, Mean Value Theorem and its Applications, Partial Derivatives, Projection and Canonical Mappings, Derivative Matrix, Continuously differential Maps, Higher Derivatives, Taylor's Formula, Implicit and Inverse Function Theorems.
UNIT 5	Integral Calculus in Banach Space, Fundamental Theorem of Calculus, Mean Value Theorem, Ordinary Differential Equations in a Banach, k-Lipschit Mapping, Existence and Uniqueness Theorems for Approximate Solutions.

Text Books:

1. Erwin Kreyszig, Introductory Functional Analysis with Applications, John Wileyand Sons (Asia). Pvt. Ltd.,2006.
2. George Bachman and Lawrence Narici, Functional Analysis, Dover,2000.

Reference Books:

1. Jchn B. Conway. A course in Functional Analysis, second edition, Springer-Verlag. 2006.
2. Martin Schechter, Principles of Functional Analysis, second edition. AMS Bookstore, 2002.
3. V.S. Sunder. Functional Analysis. Spectral Theory, Birkhauser Texts, Basel. 1997.

Course Outcomes:

CO1:- Understanding the basic concept of Hilbert space and its properties, Cauchy-Schwartz inequality.
CO2:- Understanding the Orthonormal sets and its applications.
CO3:- Understanding the Adjoint of an operator on a Hilbert space, Eigen values and eigen vectors of an operator, Spectrum of an operator Spectral theorem.
CO4:- Understanding the Differential calculus in Banach Space, Differentiability of Mappings between Banach Space.
CO5:- Understanding the Integral Calculus in Banach Space, Fundamental Theorem of Calculus, Mean Value Theorem, Ordinary Differential Equations in a Banach, k-Lipschit Mapping, Existence and Uniqueness theorems for approximate solutions.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Outcome	Program Outcome							Program Specific Outcome		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	L	L	H		M			L	M	H
CO2	L		L	M	L			M	M	M
CO3		L	M	M	M			L	L	M
CO4		M	M	L	H	L			M	H
CO5	H	H	M	M	M		L	M	L	H

H = Highly Related; M = Medium L = Low

MMA013A	Numerical Analysis	3-1-0 [4]

OBJECTIVE:

- This course helps students to have an in-depth knowledge of various advanced methods in numericalanalysis.
- This includes solution of algebraic and transcendental equations, finite element method and ordinary and partial differentialequations.

Unit 1	Numerical solutions of integral equations using Newton- Cotes, Lagrange`s linear interpolation and Chebyshev polynomial.
Unit 2	Matrix Computations: System of linear equations, Conditioning of Matrices, Matrix inversion method, Matrix factorization, Tridiagonal systems.
Unit 3	Numerical solutions of system of simultaneous first order differential equations and second order initial value problems (IVP) by Euler and Runge-Kutta (IV order) explicit methods.
Unit 4	Numerical solutions of second order boundary value problems (BVP) of first, second and third types by shooting method and finite difference methods.
Unit 5	Finite Element method: Introduction, Methods of approximation: Rayleigh-Ritz Method, Gelarkin Method and its application for solution of ordinary BVP.

Suggested Readings

1. M. K. Jain, S. R. K. Iyenger and R. K. Jain, Numerical Methods for Scientific and Engineering Computations, New Age Publications,2003.
2. M. K. Jain, Numerical Solution of Differential Equations, 2nd edition,Wiley-Eastern.
3. S. S. Sastry, Introductory Methods of Numerical Analysis,2008.
4. S. Gupta, Text Book on Calculas of Variation, Prentice-Hall of India,2002.

Course Outcomes

CO1:- Understanding the difference between Cartesian coordinates and curvilinear coordinates.

CO2:- Understanding the basics concepts of Tensors and its components.

CO3:- Understanding the basics concepts of Riemann space metric.

CO4:- Understanding the various techniques to calculate Christoffel symbols, covariant differentiation of tensors.

CO5:- Developing the ability to understand Einstein space, Bianchi’s identity.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Outcome	Program Outcome							Program Specific Outcome		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1		L	H		M			L	M	H
CO2			L	M	H			M	M	H
CO3		L	L	M	H			L	L	M
CO4		M	M	L	H	L			M	M
CO5	H	H	M	M	L		L	M	L	H

H = Highly Related; M = Medium; L = Low

ELECTIVE (Any two of the following)

MMA014A	Mathematical Modeling	3-1-0 [4]

OBJECTIVE:

- To develop an understanding of MathematicalModeling.
- To develop an understanding of linear growth and decay models, nonlinear growth and decay models, Compartmentmodels.
- To develop an understanding of Basic theory of linear difference equations with constantcoefficients.
- To develop an understanding through linear programming, linear programming models in forest management, Transportation and assignmentmodels.

Unit 1	Simple situations requiring mathematical modeling, techniques of mathematical modeling, Classifications, Characteristics and limitations of mathematical models, Some simple illustrations.
Unit 2	Mathematical modeling through differential equations, linear growth and decay models, Nonlinear growth and decay models, Compartment models, Mathematical modeling in dynamics through ordinary differential equations of first order.
Unit 3	Mathematical models through difference equations, some simple models, Basic theory of linear difference equations with constant coefficients, Mathematical modeling through difference equations in economic and finance, Mathematical modeling through difference equations in population dynamic and genetics.
Unit 4	Situations that can be modeled through graphs. Mathematical models in terms of Directed graphs, Mathematical models in terms of signed graphs, Mathematical models in terms of weighted digraphs.
Unit 5	Mathematical modeling through linear programming, Linear programming models in forest management. Transportation and assignment models.

Suggested Readings

1. J. N. Kapur, Mathematical Modeling, Wiley Eastern,2002
2. D. N. Burghes, Mathematical Modeling in the Social Management and Life Science, Ellie Herwood and John Wiley,2000.
3. Edward A. Bender, An Introduction to Mathematical Modeling, Dover publication, 2000.
4. J. N. Kapur, Mathematical Modelling (English) 1st Edition, New Age International Publishers Ltd.-New Delhi,1998.

<u>Course Outcomes</u>

CO1:- Understanding the Simple situations requiring mathematical modeling, techniques of mathematical modeling, Classifications, Characteristics and limitations of mathematical models.

CO2:- Understanding the Mathematical modeling through differential equations, linear growth and decay models, Non-linear growth anddecay models, Compartment models, Mathematical modeling in dynamics through ordinary differential equations of first order.

CO3:- Understanding the Mathematical models through difference equations, some simple models, Basic theory of linear difference equations with constant coefficients, Mathematical modeling through difference equations in economic and finance, Mathematical modeling through difference equations in population dynamic and genetics.

CO4:- Understanding the Situations that can be modeled through graphs. Mathematical models in terms of Directed graphs, Mathematical models in terms of signed graphs, Mathematical models in terms of weighted digraphs.

CO5:- Understanding the Mathematical modeling through linear programming, Linear programming models in forest management. Transportation and assignment models.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Outcome	Program Outcome							Program Specific Outcome		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	H		L					L	L	H
CO2	M		L		L			L	L	H
CO3	L	H	M	L	H	H	H	M	L	H
CO4	M	H	M	H	H	L	L	H	L	M
CO5	H	H	M	H	M	L	H	M	L	M

H = Highly Related; M = Medium; L = Low

MMA015B	Operations Research	3-1-0 [4]

OBJECTIVE:

- To understand the queueingtheory.
- To describe methods for solving multi-objective programmingmethods.
- To develop an understanding of linear fractional and goalprogramming.
- To develop an understanding of Game theory.
- To understand the solving Methods for Network problems and project management.

Unit 1	Introduction to Queues and Queueing Theory, Characteristics of queueing systems, Birth-Death Process, Basic Queueing Theory (M/M/-/- Type Queues.
Unit 2	Basic Concept of Multi Objective and Multi Level Optimization. Integer Programming Mixed Integer Programming.
Unit 3	Linear Fractional Programming. Goal Programming.Sensitivity Analysis.
Unit 4	*Game Theory:* Introduction, Competitive Situations, Characteristics of Competitive Games, Maximin – Minimax Principle, Dominance.
Unit 5	Network Problems: Dijkstra's Algorithm, maximum flow problem and minimum spanning tree.NetworkScheduling by PERT/CPM.

Suggested Readings

1. F. S. Hiller and G. J. Leiberman, Introduction to Operations Research (6th Edition), McGraw-Hill International Edition,1995.
2. G. Hadley, Nonlinear and Dynamic Programming, AddisonWesley,1998.
3. H. A. Taha, Operations Research –An Introduction,Macmillan,2002
4. KantiSwarup, P. K. Gupta and Man Mohan, Operations Research, Sultan Chand & Sons, New Delhi,2004.
5. S. S. Rao, Optimization Theory and Applications, WileyEastern,1998
6. N. S. Kambo, Mathematical Programming Techniques, Affiliated East-West Press Pvt. Ltd., NewDelhi,2004.

Course Outcomes

CO1:-Understanding the basics concepts of queueing theory.
CO1:-Understanding the multi-objective programming methods.
CO3:- Understanding the basics concepts of linear fractional and goal programming.
CO4:-Understanding the various techniques to game theory.
CO5:-Developing the ability to understand network problems and project management.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Outcome	Program Outcome							Program Specific Outcome		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1		L	H		M			L	M	H
CO2			L	M	H			M	M	H
CO3		L	L	M	H			L	L	M
CO4		M	M	L	H	L			M	M
CO5	H	H	M	M	L		L	M	L	H

H = Highly Related; M = Medium; L = Low

MMA016A	Discrete Mathematics	3-1-0 [4]

OBJECTIVE:

- Students will learn core ideas in graph theory, advance graph theory andtrees.
- Understand the importance of the discrete mathematical topics for appliedscience.
- To construct mathematical models for several technical problems using theory of Computation.

Unit 1	Graph Theory: Definition of a graph, applications, Incidence and degree, Matrix representations of graph. Isolated and pendant vertices, Null graph, Isomorphism, Subgraphs, Walks, Paths and circuits, connected graphs, disconnected graphs, and components.
Unit 2	Graph Theory: Bipartite graphs. Planar graphs and their properties. Euler and Hamiltonian graph. Euler's formula for connected planar graphs. Dijkstra's algorithm Warshal's algorithm.
Unit 3	Trees: Trees and its properties, minimally connected graph, Pendant vertices in a tree, distance and centers in a tree, rooted and binary tree. Levels in binary tree, height of a tree, Spanning trees, rank and nullity. Minimal spanning trees, Kruskal's Algorithms., Directed trees, Search trees, Traversals
Unit 4	Theory of Computation: Finite automata, Deterministic and non-deterministic finite automata, Moore and Mealy machines. Regular expressions. Grammars and Languages, Derivations, Language generated by a grammar. Regular Language and regular grammar. Regular and Context free grammar, Context sensitive grammars and Languages. Pumping Lemma, Kleene's theorem.
Unit 5	as language acceptors. Universal Turing machines. Turing machine halting problem. Turing Machines: Basic definitions. Turing machines

Suggestd Readings

1. F. Harary, Graph Theory, Narosa,2002.
2. NarsinghDeo, Graph Theory with Applications to Engineering and Computer Science, Prentice-Hall of India,2003
3. W. T. Tutte, Graph Theory, Cambridge University Press,2001
4. J. E. Hopcroft, R. Motwani, and J. D. Ullman, Introduction to Automata,Languages, and Computation (2nd edition), Pearson Edition,2001.
5. P. Linz, An Introduction to Formal Languages and Automata, 3rd Edition, 1998.

Course Outcomes:

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

CO1 Students will understand the language of graphs andtrees.

CO2 Students will understand the use of graphs asmodels.

CO3 Students will understand various types of trees and methods for traversingtrees.

CO4 Apply the knowledge and skills obtained to investigate and solve a variety ofdiscrete mathematicalproblems

CO5 Communicate both technical and non-technical information in a range of forms (written, oral, electronic, graphic). Make effective use of appropriatetechnology. Reflect on your own learning and that ofpeers.