Mangalore University

Mangalagangothri -574 199

SYLLABUS

B.A./B.Sc. (Hons) Mathematics,
B.A./B.Sc. with Mathematics as a Major/Minor Subject

(ACCORDING TO NATIONAL EDUCATION POLICY 2020)

2021

Name of the Degree Program : **B.A./B.Sc.**
Discipline Course : **Mathematics**
Starting Year of Implementation : **2021-22**

Programme Outcomes (PO):

By the end of the program it is expected that the students will be benefited by the following:

PO 1	**Disciplinary Knowledge**: Bachelor degree in Mathematics is the culmination of in-depth knowledge of Algebra, Calculus, Geometry, differential equations and several other branches of pure and applied mathematics. This also leads to study the related areas such as computer science and other allied subjects
PO 2	**Communication Skills**: Ability to communicate various mathematical concepts effectively using examples and their geometrical visualization. The skills and knowledge gained in this program will lead to the proficiency in analytical reasoning which can be used for modeling and solving of real life problems.
PO 3	**Critical thinking and analytical reasoning:** The students undergoing the programme acquire ability of critical thinking and logical reasoning and capability of recognizing and distinguishing the various aspects of real life problems.
PO 4	**Problem Solving**: The Mathematical knowledge gained by the students through the programme develop an ability to analyze the problems, identify and define appropriate computing requirements for its solutions. This programme enhances students overall development and also equip them with mathematical modelling ability, problem solving skills.
PO 5	**Research related skills:** Student completing the program will develop the capability of inquiring about appropriate questions relating to the Mathematical concepts in different areas of Mathematics.
PO 6	**Information/digital Literacy**: The completion of the programme will enable the learner to use appropriate softwares to solve system of algebraic equation and differential equations.
PO 7	**Self – directed learning**: Student completing the program will develop an ability of working independently and to make an in-depth study of various notions of Mathematics.
PO 8	**Moral and ethical awareness/reasoning:** The student completing the program will develop an ability to identify unethical behavior such as fabrication, falsification or misinterpretation of data and adopting objectives, unbiased and truthful actions in all aspects of life, in general and Mathematical studies, in particular.
PO 9	**Lifelong learning**: The programme provides self-directed learning and lifelong learning skills. The programme helps the learner to think independently and develop algorithms and computational skills for solving real word problems.
PO 10	Ability to peruse advanced studies and research in pure and applied Mathematical sciences.

Assessment

Weightage for the Assessments (in percentage)

Type of Course	Formative Assessment/ I.A.	Summative Assessment (S.A.)
Theory	40%	60 %
Practical	50%	50 %
Projects	40%	60 %
Experiential Learning (Internship etc.)	--	--

Contents of Courses for B.A./B.Sc. with Mathematics as Major Subject & B.A./B.Sc. (Hons) Mathematics

(Model IIA suggested by the Karnataka State Higher Education Council)

Semester	Course No.	Theory/ Practical	Credits	Paper Title	Marks	
					S.A.	I.A.
I	MATDSCT1.1	Theory	4	Number Theory-I, Algebra-I and Calculus-I	60	40
	MATDSCP1.1	Practical	2	Theory based Practicals on Number Theory-I, Algebra-I and Calculus-I	25	25
	MATOET1.1	Theory	3	(A) Mathematics - I (B) Business Mathematics - I	60	40
II	MATDSCT2.1	Theory	4	Number Theory-II, Algebra - II and Calculus - II	60	40
	MATDSCP2.1	Practical	2	Theory based Practicals on Number Theory-II, Algebra - II and Calculus - II	25	25
	MATOET2.1	Theory	3	(A) Mathematics – II (B) Business Mathematics-II	60	40
Exit Option with Certificate						
III	MATDSCT3.1	Theory	4	Ordinary Differential Equations and Algebra - III	60	40
	MATDSCP3.1	Practical	2	Theory based Practicals on Ordinary Differential Equations and Algebra - III	25	25
	MATOET3.1	Theory	3	(A) Ordinary Differential Equations (B) Mathematical Logic	60	40
IV	MATDSCT4.1	Theory	4	Partial Differential Equations and Integral Transforms	60	40
	MATDSCP4.1	Practical	2	Theory based Practicals on Partial Differential Equations and Integral Transforms	25	25
	MATOET4.1	Theory	3	(A) Partial Differential Equations (B) Mathematical Finance	60	40
Exit Option with Diploma						
V	MATDSCT5.1	Theory	3	Real and Complex Analysis	60	40
	MATDSCP5.1	Practical	2	Theory based Practicals on Real and Complex Analysis	25	25
	MATDSCT5.2	Theory	3	Modern Algebra - I	60	40
	MATDSCP5.2	Practical	2	Theory based Practicals Modern Algebra - I	25	25
	MATDSET5.1	Theory	3	Any ONE of the following electives: a) Vector Calculus b) Elementary Graph Theory c) Discrete Mathematics	60	40
VI	MATDSCT6.1	Theory	3	Linear Algebra - I	60	40
	MATDSCP6.1	Practical	2	Theory based Practicals on Linear Algebra - I	25	25
	MATDSCT6.2	Theory	3	Numerical Analysis	60	40

	MATDSCP6.2	Practical	2	Theory based Practicals on Numerical Analysis	25	25
	MATDSET6.1	Theory	3	Any ONE of the following electives: a) Analytical Geometry in 3D b) Linear Programming c) Special Functions d) Fourier Series and Fourier Transforms	60	40
Exit Option with Bachelor of Arts (B.A.)/ Bachelor of Science(B.Sc.) Degree						
VII	MATDSCT7.1	Theory	3	Linear Algebra -II	60	40
	MATDSCP7.1	Practical	2	Theory based Practicals on Linear Algebra -II	25	25
	MATDSCT7.2	Theory	3	Advanced Ordinary Differential Equations	60	40
	MATDSCP7.2	Practical	2	Theory based Practicals on Advanced Ordinary Differential Equations	25	25
	MATDSCT7.3	Theory	4	Advanced Real Analysis	60	40
	MATDSET 7.1	Theory	3	Any ONE of the following electives: a) Graph Theory b) Advanced Number Theory c) Mathematical Statistics d) Advanced Numerical Analysis	60	40
	MATDSET 7.2	Theory	3	Research Methodology in Mathematics	60	40
VIII	MATDSCT8.1	Theory	4	Advanced Complex Analysis	60	40
	MATDSCT8.2	Theory	4	Abstract Algebra	60	40
	MATDSCT8.3	Theory	3	General Topology	60	40
	MATDSET 8.1	Theory	3	Any ONE of the following electives: a) Operations Research b) Lattice theory c) Mathematical Modelling d) Advanced Discrete Mathematics	60	40
	MATDSET 8.2	Research Project	6 (3 + 3)	Research Project OR Any TWO of the following electives a) Theory of Modules b) Theory of Partitions c) Cryptography d) Finite Element Methods	120 OR 60 60	80 OR 40 40
Award of Bachelor of Arts Honours (B.A. Hons)/ Bachelor of Science Honours (B.Sc. Hons) Degree in Mathematics						

Abbreviation for MATDSCTx.y/MATDSCPx.y/MATDSETx.y/MATOETx.y
MAT – Mathematics;
DSC – Discipline Core; **DSE** – Discipline Elective; **OE** – Discipline Elective;
T – Theory, **P** – Practical;
x.y–x^{th} Semester.Course y

MATOETx.y(A) - For students of Science stream who have not chosen Mathematics as one of Core subjects
MATOETx.y(B) - For Students of other than Science Stream

CURRICULUM STRUCTURE FOR UNDERGRADUATE DEGREE PROGRAM

Name of the Degree Program : B.A. / B.Sc. (Honors)

Discipline/Subject : Mathematics

Starting Year of Implementation: 2021-22

PROGRAM ARTICULATION MATRIX

Semester	Course No.	Programme Outcomes that the Course Addresses	Pre-Requisite Course(s)	Pedagogy*	Assessment**
I	MATDSCT1.1	PO 1, PO 2, PO 3	PU level Mathematics	MOOC	CLASS TESTS
II	MATDSCT2.1	PO 1, PO 2, PO 3, PO 8	MATDSCT1.1	PROBLEM SOLVING	SEMINAR
III	MATDSCT3.1	PO 1, PO 4, PO7, PO 8	MATDSCT2.1	SEMINAR	QUIZ
IV	MATDSCT4.1	PO 1, PO 4, PO7, PO 8	MATDSCT3.1	PROJECT BASED LEARNING	ASSIGNMENT
V	MATDSCT5.1	PO 1, PO 2, PO 3, PO 5	----		
V	MATDSCT5.2	PO 3, PO 4, PO 7, PO10	MATDSCT2.1 MATDSCT3.1	ASSIGNMENTS	
VI	MATDSCT6.1	PO 6, PO 7, PO 10.	MATDSCT5.2	GROUP DISCUSSION	
VI	MATDSCT6.2	PO 5, PO 8, PO 9, PO 10.	MATDSCT5.1		
VII	MATDSCT7.1	PO 3, PO 4, PO5, PO 7, PO 9.	MATDSCT6.1		TERM END EXAM
VII	MATDSCT7.2	PO 2, PO 4, PO 5, PO 10	MATDSCT3.1		
VII	MATDSCT7.3	PO 2, PO 4, PO 5, PO 10	MATDSCT5.1		
VIII	MATDSCT8.1	PO 2, PO 4, PO 5, PO 10	MATDSCT5.1		
VIII	MATDSCT8.2	PO 2, PO 4, PO 5, PO 10	MATDSCT5.2		
VIII	MATDSCT8.3	PO 2, PO 4, PO 5, PO 10	MATDSCT5.1		VIVA-VOCE

*Pedagogy for student engagement is predominantly Lecture. However, other pedagogies enhancing better student engagement to be recommended for each course. This list includes active learning/ course projects / Problem based or Project based Learning / Case Studies / Self Study like Seminar, Term Paper or MOOC.

**Every Course needs to include assessment for higher order thinking skills (Applying/ Evaluating/ Creating). However, this column may contain alternate assessment methods that help formative assessment (i.e. assessment for Learning).

B.A./B.Sc. with Mathematics as a Minor in the 3rd Year

Semester	Course No.	Theory/ Practical	Credits	Paper Title	Marks	
					S.A.	I.A.
V	MATDSCMT5.1	Theory	3	Complex Analysis	60	40
	MATDSCMP5.1	Practical	2	Theory based Practicals on Complex Analysis	25	25
VI	MATDSCMT6.1	Theory	3	Numerical Analysis	60	40
	MATDSCMP6.1	Practical	2	Theory based Practicals on Numerical Analysis	25	25

Abbreviation for MATDSCMT5.1 / MATDSCMP5.1

MAT – Mathematics; **DSC** – Discipline Core; **M** – Minor; **T** – Theory /**P** – Practical; **5** – Fifth Semester; **.1** – Course 1

Credit Distribution for B.A./B.Sc.(Honors) with Mathematics as Major in the 3rd Year
(Model IIA suggested by the Karnataka State Higher Education Council)

Subject	Semester	Major/ Minor in the 3rd Year	Credits					
			Discipline Specific Core (DSC)	Open Elective (OE)	Discipline Specific Elective (DSE)	AECC & Languages	Skill Enhancement Courses (SEC)	Total Credits
Mathematics	I - IV	Major	4 Courses (4+2)x 4=24	4 Courses 3 x 4 = 12	---	(4+4=8) Courses 8x(3+1)=32	2 Courses 2x(1+1)= 4	72
Other Subject		Minor	24	--	--	--	--	24
96								
Mathematics	V & VI	Major	4 Courses 4x(3+2)=20	-----	2 Courses 2 x 3 = 06	---	2 Courses 2 x 2 = 4	30
Other Subject		Minor	10	--	--	--	--	10
(96+40)=136								
Mathematics	VII & VIII	Major	2 Courses 2x(3+2)=10 3 Courses 3 x 4 = 12 1 Course 1 x 3 = 3 Total=25	-----	2 Courses 2 x 3 = 6 Res.Meth 1 x 3 = 3 2 Courses 2 x 3 = 6 Total= 15	----	-----	40
Total No. of Courses			14	04	07	08	04	
136+40=176								

Syllabus for B.A./B.Sc. with Mathematics as Major Subject & B.A./B.Sc. (Hons.) Mathematics

SEMESTER – I

MATDSCT1.1: Number Theory-I, Algebra-I and Calculus-I	
Teaching Hours : 4 Hours/Week	**Credits: 4**
Total Teaching Hours: 56 Hours	**Max. Marks: 100 (S.A.- 60 + I.A. – 40)**

Course Learning Outcomes: This course will enable the students to

- Understand the elementary concepts of Number Theory.
- Solve the system of homogeneous and non-homogeneous m linear equations in n variables.
- Sketch curves in Cartesian and polar co-ordinates.
- Identify and apply intermediate value theorem, mean value theorems and L'Hospital rule.

Unit-I: Number Theory: Division Algorithm, The Greatest Common Divisor (g.c.d), Euclidean Algorithm, Diophantine Equations, Fundamental Theorem of Arithmetic. The Theory of Congruences, Basic Properties of Congruences, Binary and Decimal Representation of Integers. Linear Congruences and The Chinese Remainder Theorem. **14 Hours**

Unit-II: Matrices: Recapitulation of Symmetric and Skew Symmetric matrices, Cayley-Hamilton theorem, inverse of matrices by Cayley-Hamilton theorem (Without Proof). Algebra of Matrices, Row and column reduction to Echelon form. Rank of a matrix, Inverse of a matrix by elementary operations, Solution of system of linear equations, Criteria for existence of non-trivial solutions of homogeneous system of linear equations. Solution of non-homogeneous system of linear equations. **14 Hours**

Unit-III: Polar Co-ordinates: Polar coordinates, angle between the radius vector and tangent. Angle of intersection of two curves (polar forms), length of perpendicular from pole to the tangent, pedal equations. Derivative of an arc in Cartesian, parametric and polar forms, curvature of plane curve-radius of curvature formula in Cartesian, parametric and polar and pedal forms- center of curvature, asymptotes, Tracing of curves (standard curves). **14 Hours**

Unit-IV: Differential Calculus: Intermediate value theorem, Rolle's Theorem, Lagrange's Mean Value theorem, Cauchy's Mean value theorem and examples. Taylor's theorem, Maclaurin's series, Indeterminate forms and evaluation of limits using L' Hospital rule. Leibnitz theorem and its applications. **14 Hours**

Reference Books:

[1] David M. Burton., Elementary Number Theory, 7th Ed., McGraw Hill, 2011.

[2] Gareth A. Jones and J. Marry Jones, Elementary Number Theory, Springer, 1998.

[3] N. S Gopalakrishnan, University Algebra, 3rd Ed., New Age International Publications, 2015.

[4] B. S. Vatssa, Theory of Matrices, New Age International Publishers, New Delhi, 2005.

[5] A. R. Vasishtha and A. K. Vasishtha, Matrices, Krishna Prakashana Media (P) Ltd., 2008.
[6] Shanti Narayan and P.K. Mittal, Text book of Matrices, 5th Ed., S Chand and Co. Pvt. Ltd., New Delhi, 2013.
[7] Shanthi Narayan and P.K. Mittal, Differential Calculus, Reprint. S Chand and Co. Pvt. Ltd., New Delhi, 2014.
[8] Debasish Sengupta, Applications of Calculus, Books and Allied (P) Ltd., 2019.
[9] George B. Thomas and Ross L. Finney, Calculus and Analytic Geometry, Addison-Wesley, 1992.
[10] Louis Leithold, Calculus with Analytic Geometry, 5th Ed., Harper and Row International, 1986.
[11] Maurice D. Weir, George B. Thomas, Jr., Joel Hass and Frank R. Giordano, Thomas' Calculus, 11th Ed., Pearson, 2008.
[12] S. Narayanan and T. K. Manicavachogam Pillay, Calculus, Vol. I & II, S. Viswanathan Pvt. Ltd., 1996.

MATDSCP1.1: Practicals on Number Theory-I, Algebra-I and Calculus-I	
Practical Hours : 4 Hours/Week	**Credits: 2**
Total Practical Hours: 56 Hours	**Max. Marks: 50 (S.A.-25 + I.A. – 25)**

Course Learning Outcomes: This course will enable the students to

- Learn *Free and Open Source Software (FOSS)* tools for computer programming.
- Solve problems on Number theory, Algebra and Calculus studied in **MATDSCT 1.1** by using FOSS softwares.
- Acquire knowledge of applications of algebra and calculus through FOSS.

Practical/Lab Work to be performed in Computer Lab (FOSS)

Suggested Softwares: Maxima/Scilab/Python.

1. Introduction to the software and commands related to the topic.
2. Program for Euclidean Algorithm.
3. Program for Divisibility tests.
4. Programs for Binary and Decimal Representation of Integers.
5. Program to solve Simultaneous Congruences involving Chinese Remainder Theorem.
6. Computation of addition and subtraction of matrices.
7. Computation of Multiplication of matrices.
8. Computation of Trace and Transpose of Matrix.
9. Computation of Rank and Row reduced Echelon form of a matrix.
10. Computation of Inverse of an invertible Matrix using Cayley-Hamilton theorem.
11. Solving systems of homogeneous and non-homogeneous linear algebraic equations.
12. Tracing of standard curves (Cartesian form).
13. Tracing of standard curves (Polar form).
14. Taylor's and Maclaurin's expansions of the given functions.

Open Elective Course

(For students of Science stream who have not chosen Mathematics as one of Core subjects)

MATOET1.1 (A): Mathematics - I	
Teaching Hours : 3 Hours/Week	**Credits: 3**
Total Teaching Hours: 42 Hours	**Max. Marks: 100 (S.A.- 60 + I.A. – 40)**

Course Learning Outcomes: This course will enable the students to

- Understand the elementary concepts of Number Theory.
- Solve the system of homogeneous and non-homogeneous m linear equations in n variables.
- Identify and apply intermediate value theorem, mean value theorems and L'Hospital rule.

Unit-I: Number Theory: Division Algorithm, The Greatest Common Divisor (g.c.d), Euclidean Algorithm, Diophantine Equations, Fundamental Theorem of Arithmetic. Theory of Congruences, Basic Properties of Congruences, Binary and Decimal Representation of Integers. Linear Congruences and The Chinese Remainder Theorem. **14 Hours**

Unit-II: Matrices: Recapitulation of Symmetric and Skew Symmetric matrices, Cayley-Hamilton theorem, inverse of matrices by Cayley-Hamilton theorem (Without Proof). Algebra of Matrices, Row and column reduction to Echelon form. Rank of a matrix, Inverse of a matrix by elementary operations, Solution of system of linear equations, Criteria for existence of non-trivial solutions of homogeneous system of linear equations. Solution of non-homogeneous system of linear equations. **14 Hours**

Unit-III: Differential Calculus: Intermediate value theorem, Rolle's Theorem, Lagrange's Mean Value theorem, Cauchy's Mean value theorem and examples. Taylor's theorem, Maclaurin's series, Indeterminate forms and evaluation of limits using L' Hospital rule. Leibnitz theorem and its applications. **14 Hours**

Reference Books:

[1] David M. Burton., Elementary Number Theory, 7th Ed., McGraw Hill, 2011.

[2] Gareth A. Jones and J. Marry Jones, Elementary Number Theory, Springer, 1998.

[3] N. S Gopalakrishnan, University Algebra, 3rd Ed., New Age International Publications, 2015.

[4] B. S. Vatssa, Theory of Matrices, New Age International Publishers, New Delhi, 2005.

[5] A. R. Vasishtha and A. K. Vasishtha, Matrices, Krishna Prakashana Media (P) Ltd., 2008.

[6] Shanti Narayan and P.K. Mittal, Text book of Matrices, 5th Ed., S Chand and Co. Pvt. Ltd., New Delhi, 2013.

[7] Shanthi Narayan and P.K. Mittal, Differential Calculus, Reprint. S Chand and Co. Pvt. Ltd., New Delhi, 2014.

[8] Debasish Sengupta, Applications of Calculus, Books and Allied (P) Ltd., 2019.

[9] George B. Thomas and Ross L. Finney, Calculus and Analytic Geometry, Addison-Wesley, 1992.

[10] Maurice D. Weir, George B. Thomas, Jr., Joel Hass and Frank R. Giordano, Thomas' Calculus, 11th Ed., Pearson, 2008.
[11] S. Narayanan and T. K. Manicavachogam Pillay, Calculus, Vol. I & II, S. Viswanathan Pvt. Ltd., 1996.

Open Elective

(For Students of other than Science Stream)

MATOET1.1 (B): Business Mathematics-I	
Teaching Hours : 3 Hours/Week	**Credits: 3**
Total Teaching Hours: 42 Hours	**Max. Marks: 100 (S.A.- 60 + I.A. – 40)**

Course Learning Outcomes: This course will enable the students to

- Solve the system of homogeneous and non-homogeneous m linear equations in n variables.
- Translate the real world problems through appropriate mathematical modeling.
- Explain the concepts and use equations, formulae and mathematical expressions in a variety of context.
- Find the extreme values of functions.
- Analyze and demonstrate the mathematical skill required in mathematically intensive areas such as economics, business etc.

Unit-I: Matrices: Definition of a matrix, types of matrices, algebra of matrices. Properties of determinants; calculations of values of determinants up to third order, Adjoint of a matrix, elementary row and column operations, solution of a system of linear equations having unique solution and involving not more than three variables. Examples on commercial mathematics. **14 Hours**

Unit-II: Straight line and Conics: Straight line in economics, Break-Even point, System of straight lines, Effect of a Tax or Subsidy. Parabola in economics, The non-linear model. Rectangular hyperbola: Rectangular hyperbola in economics. Circle in economics. Inequalities and absolute values: Properties of inequalities, Linear inequality in one variable, Absolute values. Applications in economics. **14 Hours**

Unit-III: Derivatives of functions: Economic applications, Demand function, Price demand, income demand, Cross demand, Law of supply, Revenue functions, Short-run production function, Short-run cost function, Relation between marginal product and marginal cost. The maxima and minima of functions: Applications of maxima and minima of functions in economics and business. **14 Hours**

Reference Books:

[1] B. S. Vatssa, Theory of Matrices, New Age International Publishers, New Delhi, 2005.
[2] A. R. Vasishtha and A. K. Vasishtha, Matrices, Krishna Prakashana Media (P) Ltd., 2008.
[3] Shanti Narayan and P.K. Mittal, Text book of Matrices, 5th Ed., S. Chand and Co. Pvt. Ltd., New Delhi, 2013.

[4] E.T. Dowling, Mathematics for Economics, Schaum's Outline, 3rd Ed., McGraw Hill, London, 2011.
[5] R.G.D. Allen, Basic Mathematics, Macmillan, UK, 1968.
[6] N.D. Vohra, Quantitative Techniques in Management, Tata McGraw Hill, New Delhi, 2007.
[7] R. S. Soni, Business Mathematics with Applications in Business and Economics, Pitambar Publishing, India 1996.
[8] Maurice D. Weir, George B. Thomas, Jr., Joel Hass and Frank R. Giordano, Thomas' Calculus, 11th Ed., Pearson, 2008.

SEMESTER – II

MATDSCT 2.1: Number Theory-II, Algebra-II and Calculus-II	
Teaching Hours : 4 Hours/Week	**Credits: 4**
Total Teaching Hours: 56 Hours	**Max. Marks: 100 (S.A.- 60 + I.A. – 40)**

Course Learning Outcomes: This course will enable the students to

- Understand the Euler's ϕ-function and finite continued fractions.
- Recognize the mathematical objects called Groups.
- Identify cyclic and non-cyclic groups
- Link the fundamental concepts of groups and symmetries of geometrical objects.
- Understand the concept of partial derivatives of functions of several variables.
- Find the Taylor's and Maclaurin's series of functions of two variables.
- Find the extreme values of functions of two variables.
- Understand the concepts of line integrals, multiple integrals and their applications.

Unit-I: Number Theory: Fermat's Theorem, Wilson's Theorem, Quadratic Congruence. Euler's ϕ-function, definition and properties, Euler's theorem and corollaries, finite continued fractions. **14 hours**

Unit-II: Groups: Binary Operations, Associativity, Commutativity, Examples for Binary Operations, Definition of a Group, Examples, Right inverse, Left inverse, Some properties, Abelian and Non-abelian groups, Laws of exponents, Subgroups, Intersection of subgroups, Centralizer of an element, Normalizer of a subgroup, Product of subgroups, Order of products of subgroups, Cyclic groups, Properties, Number of generators. **14 hours**

Unit-III: Partial Derivatives: Functions of two or more variables-explicit and implicit functions, partial derivatives. Homogeneous functions- Euler's theorem, total derivatives, differentiation of implicit and composite functions, Jacobians and standard properties and illustrative examples. Taylor's and Maclaurin's series for functions of two variables, Maxima-Minima of functions of two variables. **14 hours**

Unit-IV: Integral Calculus: Recapitulation of definite integrals and its properties. *Line integral*: Definition of line integral and basic properties, examples on evaluation of line

integrals. *Double integral*: Definition of Double integrals and its conversion to iterated integrals. Evaluation of double integrals by changing the order of integration and change of variables. Computation of plane surface areas, volume underneath a surface of revolution using double integral. *Triple integral*: Definition of triple integrals and evaluation-change of variables, volume as triple integral. Differentiation under the integral sign by Leibnitz rule.

14 hours

Reference Books:

[1] David M. Burton., Elementary Number Theory, 7th Ed., McGraw Hill, 2011.

[2] Gareth A. Jones and J. Marry Jones, Elementary Number Theory, Springer, 1998.

[3] N. S Gopalakrishnan, University Algebra, 3rd Ed., New Age International Publications, 2015.

[4] I. N. Herstein, Topics in Algebra, 2nd Ed., Wiley Publishers, 1975.

[5] A. R. Vasishtha and A. K. Vasishtha, Modern Algebra, Krishna Prakashan Mandir, Meerut, U.P., 2008.

[6] Bernald and Child, Higher Algebra, Arihant Publication India Limited, India, 2016.

[7] Vijay K Khanna and S K Bhambri, A Course in Abstract Algebra, 5th Ed., Vikas Publishing House, India, 2016.

[8] Shanthi Narayan and P. K. Mittal, Differential Calculus, Reprint, S. Chand and Co. Pvt. Ltd., New Delhi, 2014.

[9] Shanti Narayan and P. K. Mittal, Integral Calculus. S. Chand Ltd., India, 2005.

[10] George B. Thomas and Ross L. Finney, Calculus and Analytic Geometry, Addison-Wesley, 1992.

[11] Maurice D. Weir, George B. Thomas, Jr., Joel Hass and Frank R. Giordano, Thomas' Calculus, 11th Ed., Pearson, 2008.

[12] S. Arora and S .C. Malik, Mathematical analysis, Wiley, India, 1992.

MATDSCP2.1: Practicals on Number Theory-II, Algebra-II and Calculus-II	
Practical Hours : 4 Hours/Week	**Credits: 2**
Total Practical Hours: 56 Hours	**Max. Marks: 50 (S.A.-25 + I.A. – 25)**

Course Learning Outcomes: This course will enable the students to

- Learn *Free and Open Source Software (FOSS)* tools for computer programming.
- Solve problems on Number Theory, Algebra and Calculus by using FOSS softwares.
- Acquire knowledge of applications of algebra and calculus through FOSS.

Practical/Lab Work to be performed in Computer Lab

Suggested Softwares: Maxima/Scilab/Python.

1. Program to compute Euler's ϕ-function values for positive integers.
2. Program to write rational numbers as finite continued fractions.
3. Program to find the rational numbers corresponding to given finite continued fractions.
4. Program for verification of binary operations.
5. Programs: (i) To find identity element of a group. (ii) To find inverse of an element in a group.

6. Program to construct Cayley's table and test abelian for given finite set.
7. Program to find generators and corresponding possible subgroups of a cyclic group.
8. Finding all possible subgroups of a finite group.
9. Obtaining partial derivative of some standard functions.
10. Solutions of optimization problems.
11. Programs to develop Maclaurin's expansion for functions of two variables.
12. Program to evaluate the line integrals.
13. Program to evaluate the Double integrals with constant and variable limits.
14. Program to evaluate the Triple integrals with constant and variable limits.

Open Elective

(For students of Science stream who have not chosen Mathematics as one of the Core subjects)

MATOET2.1(A): Mathematics – II	
Teaching Hours : 3 Hours/Week	**Credits: 3**
Total Teaching Hours: 42 Hours	**Max. Marks: 100** **(S.A.- 60 + I.A. – 40)**

Course Learning Outcomes: This course will enable the students to

- Recognize the mathematical objects called Groups.
- Identify cyclic and non-cyclic groups
- Link the fundamental concepts of groups and symmetries of geometrical objects.
- Find the extreme values of functions of two variables.
- Understand the concepts of line integrals, multiple integrals and their applications.

Unit-I: Groups: Binary Operations, Associativity, Commutativity, Examples for Binary Operations, Definition of a Group, Examples, Right inverse, Left inverse, Some properties, Abelian and Non-abelian groups, Laws of exponents, Subgroups, Intersection of subgroups, Centralizer of an element, Normalizer of a subgroup, Product of subgroups, Order of products of subgroups, Cyclic groups, Properties, Number of generators. **14 hours**

Unit-II: Partial Derivatives: Functions of two or more variables-explicit and implicit functions, partial derivatives. Homogeneous functions- Euler's theorem, total derivatives, differentiation of implicit and composite functions, Jacobians and standard properties and illustrative examples. Taylor's and Maclaurin's series for functions of two variables, Maxima-Minima of functions of two variables. **14 hours**

Unit-III: Integral Calculus: Recapitulation of definite integrals and its properties. *Line integral*: Definition of line integral and basic properties, examples on evaluation of line integrals. *Double integral*: Definition of Double integrals and its conversion to iterated integrals. Evaluation of double integrals by changing the order of integration and change of variables. Computation of plane surface areas, volume underneath a surface of revolution using double integral. *Triple integral*: Definition of triple integrals and evaluation-change of variables, volume as triple integral. Differentiation under the integral sign by Leibnitz rule. **14 hours**

Reference Books:

[1] N. S Gopalakrishnan, University Algebra, 3rd Ed., New Age International Publications, 2015.

[2] I. N. Herstein, Topics in Algebra, 2nd Ed., Wiley Publishers, 1975.

[3] A. R. Vasishtha and A. K. Vasishtha, Modern Algebra, Krishna Prakashan Mandir, Meerut, U.P., 2008.

[4] Bernald and Child, Higher Algebra, Arihant Publication India Limited, India, 2016.

[5] Vijay K Khanna and S K Bhambri, A Course in Abstract Algebra, 5th Ed., Vikas Publishing House, India, 2016.

[6] Shanthi Narayan and P. K. Mittal, Differential Calculus, Reprint, S Chand and Co. Pvt. Ltd., New Delhi, 2014.

[7] Shanti Narayan and P. K. Mittal, Integral Calculus. S. Chand Ltd., India, 2005.

[8] George B. Thomas and Ross L. Finney, Calculus and Analytic Geometry, Addison-Wesley, 1992.

[9] Maurice D. Weir, George B. Thomas, Jr., Joel Hass and Frank R. Giordano, Thomas' Calculus, 11th Ed., Pearson, 2008.

[10] S. Arora and S .C. Malik, Mathematical analysis, Wiley, India, 1992.

Open Elective

(For Students of other than science stream)

MATOET2.1(B): Business Mathematics-II	
Teaching Hours : 3 Hours/Week	**Credits: 3**
Total Teaching Hours: 42 Hours	**Max. Marks: 100** **(S.A.- 60 + I.A. – 40)**

Course Learning Outcomes: This course will enable the students to

- Integrate concepts in international business with functioning global trade.
- Evaluate the legal, social and economic environment of business.
- To learn different techniques of simplification of real number system
- To enable student to answer competitive examinations
- Will be able to apply knowledge of business concepts and functions in an integrated manner.

Unit-I: Commercial Arithmetic: Interest: Concept of Present value and Future value, Simple interest, Compound interest, Nominal and Effective rate of interest, Examples and Problems Annuity: Ordinary Annuity, Sinking Fund, Annuity due, Present Value and Future Value of Annuity, Equated Monthly Instalments (EMI) by Interest of Reducing Balance and Flat Interest methods, Examples and Problems. **14 Hours**

Unit II: Techniques of solving problems involving number system and decimal fraction to calculate share of profit ,simplification of equations involving cost and expenditure, Average, Profit and loss. **14 Hours**

Unit III: Percentage, Ratio and proportion, Partnership, Time and work, Situations in Boats and Streams, Simple problems on trains and other moving objects, different types of problems in Calendar, number of days and dates to calculate period of payments, Stocks and shares and Problems related clock. **14 Hours**

Reference Books:

[1] R. S. Agarwal, Quantitative Aptitude, S. Chand & company Pvt. Ltd., 2014.

[2] S. A. Bari, Practical Business Mathematics, New Literature Publishing Company, Bombay, 1971.

[3] K. Selvakumar, Mathematics for Commerce, Notion Press, Chennai, 2014.

[4] Dinesh Khattar and S. R. Arora, Business Mathematics with Applications, S. Chand Publishing, New Delhi, 2001.

[5] M. K. Bhowal, Fundamentals of Business Mathematics, Asian Books Pvt. Ltd., New Delhi, 2009

[6] Martin Anthony and Norman Biggs, Mathematics for Economics and Finance: Methods and Modelling, Cambridge University Press, Cambridge, 1996.

[7] Ahmad Nazri and Wahidudin, Financial Mathematics and its Applications, Ventus Publishing, APS, Denmark, 2011.

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SYLLABUS
(Semester III and IV)

B.A./B.Sc. (Hons) Mathematics,
B.A./B.Sc. with Mathematics as a Major/Minor Subject
(ACCORDING TO NATIONAL EDUCATION POLICY 2020)

2022

Syllabus for B.A./B.Sc. with Mathematics as Major Subject
&
B.A./B.Sc. (Hons) Mathematics

SEMESTER – III
(2022-23 onwards)

MATDSCT 3.1: Ordinary Differential Equations and Real Analysis – I	
Teaching Hours: 4 Hours/Week	**Credits: 4**
Total Teaching Hours: 56 Hours	**Max. Marks: 100 (SEE- 60 + I.A. - 40)**

Course Learning Outcomes: This course will enable the students to:

- Solve first-order non-linear differential equations and linear differential equations.
- To model problems in nature using Ordinary Differential Equations.
- Formulate differential equations for various mathematical models
- Apply these techniques to solve and analyze various mathematical models.
- Understand the fundamental properties of the real numbers that lead to define sequence and series, the formal development of real analysis.
- Learn the concept of Convergence and Divergence of a sequence.
- Able to handle and understand limits and their use in sequences, series, differentiation, and integration.
- Apply the ratio, root, alternating series, and limit comparison tests for convergence and absolute convergence of an infinite series.

Ordinary Differential Equations:

Unit I: Recapitulation of Differential Equations of first order and first degree, Exact Differential equations, Necessary and sufficient condition for the equations to be exact, Reducible to the exact differential equations. Differential equations of the first order and higher degree: Equations solvable for p, x, y. Clairaut's equation and singular solution. Orthogonal trajectories of Cartesian and polar curves. **14hrs**

Unit II: Linear differential equations of the n^{th} order with constant coefficients. Particular Integrals when the RHS is of the form e^{ax}, $\sin(ax+b)$, $\cos(ax+b)$, x^n, $e^{ax}\ V$ and xV (with proofs), where V is a function of x. Cauchy – Euler equations, Legendre differential equations, Method of variation of parameters. Simultaneous differential equations with two and more than two variables. Condition for integrability of total differential equations $P\,dx + Q\,dy + R\,dz = 0$.

14 hrs

Unit III: Sequences: Recapitulation of number system - Real line, bounded sets, suprimum and infimum of a set, Archimedean property of R. Intervals, neighborhood of a point, open sets, closed sets, limit points.

Sequences of real numbers, Bounded sequences. Limit of a sequence. convergent, divergent, and oscillatory sequences. Monotonic sequences. Algebra of convergent sequences. Limit points of a sequence. Bolzano Weierstrass theorem for sequence. Limit superior and limit inferior of sequences. Cauchy's first and second theorem on limits of a sequence. Cauchy's general principle for convergence of a sequence. Subsequence and their properties. 14hrs

Unit IV: Infinite Series: Definition of convergent, divergent and oscillatory series. Series of non-negative terms, Cauchy's general principle of convergence. Geometric series, P-series (Harmonic series). Comparison tests for positive term series. D'Alembert's ratio test, Raabe's test. Cauchy's Root test and Cauchy's integral test. Alternating series. Leibnitz's theorem. Absolute convergence and conditional convergence of a series. Summation of series: Binomial, exponential and logarithmic. **14 hrs**

Reference Books:

1. M. D. Raisinghania, *Ordinary Differential Equations & Partial Differential Equations*, S. Chand & Company, New Delhi, 20th Edition- 2020. (For Unit I and Unit II)
2. S. C. Malik, and Savitha Arora, *Mathematical Analysis*, New Age International Publishers, 5th Edition- 2017. (For Unit III and Unit IV)
3. J. Sinha Royand SPadhy: *A Course of Ordinary and Partial Differential Equation*, Kalyani Publishers, New Delhi, 4th Edition - 2014.
4. D. Murray, *Introductory Course in Differential Equations*, Orient Black Swan - 2016
5. W. T. Reid, *Ordinary Differential Equations*, John Wiley, New York - 1971.
6. S. L. Ross, *Differential Equations,* John Wiley and Sons, 3rdEdition - 1984.
7. R. G. Bartle and D. R. Sherbert, *Introduction to Real Analysis*, John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 3rdEdition - 2015.
8. K. A. Ross, *Elementary Analysis: The Theory of Calculus*, Springer, 2ndEdition - 2013
9. S. K. Berberian, *A First Course in Real Analysis,* Springer Verlag, NewYork -1994.
10. T. Apostol, *Mathematical Analysis*, Narosa Publishing House, 2nd Edition - 2002.
11. E. D. Rainville and P. E. Bedient, *Elementary Differential Equations*, Pearson, 8th Edition - 1996.

PRACTICAL

MATDSCP 3.1: Practical on Ordinary Differential Equations and Real Analysis – I	
Teaching Hours: 4 Hours/Week	**Credits: 2**
Total Teaching Hours: 56 Hours	**Max. Marks: 50** **(SEE - 25 + I.A. – 25)**

Course Learning Outcomes: This course will enable the students to gain hands-on experience of

- Free and Open Source software (FOSS) tools or computer programming.
- Solving exact differential equations
- Plotting orthogonal trajectories
- Finding complementary function and particular integral of linear and homogeneous differential equations.
- Acquire knowledge of applications of real analysis and differential equations.
- Verification of convergence/divergence of different types of series

Practical/Lab Work to be performed in Computer Lab

Use open-source software to executive the practical problems. (Maxima/Scilab/MatLab /Mathematica/Python)

1. Fundamentals of Ordinary differential equations and Real analysis using FOSS

2. Verification of exactness of a differential equation
3. Plot orthogonal trajectories for Cartesian and polar curves
4. Solutions of differential equations that are solvable for *x, y, p.*
5. To find the singular solution by using Clairaut's form.
6. Finding the Complementary Function and Particular Integral of linear and homogeneous differential equations with constant coefficients and plot the solutions.
7. Finding the Particular Integral of differential equations up to second order and plot the solutions.
8. Solutions to the Total and Simultaneous differential equations and plot the solutions.
9. Test the convergence of sequences
10. Verification of exponential, logarithm and binomial series.
11. Verification of geometric series, *p*-series, Cauchy's Integral test, root test, and D Alembert's Test
12. Examples on a series of positive terms.
13. Examples on alternating series using Leibnitz's theorem.
14. Finding the convergence of series using Cauchy's criterion for partial sums.

Open Elective Course

(For students of Science stream who have not chosen Mathematics as one of the Core Course)

MATOET3.1(A) Ordinary Differential Equations	
Teaching Hours: 3 Hours/Week	**Credits: 3**
Total Teaching Hours: 42 Hours	**Max. Marks: 100** **(SEE - 60 + I.A. – 40)**

Course Learning Outcomes: This course will enable the students to:

- Understand the concept of the differential equation and their classification
- Know the meaning of the solution of a differential equation.
- To solve first-order ordinary differential equations.
- To solve exact differential equations and Converts to separable and homogenous equations to exact differential equations by integrating factors.
- To Solve Bernoulli differential equations.
- To find the solution to higher-order linear differential equations.

Unit I: Recapitulation of Differential Equations of first order and first degree, Exact Differential equations, Necessary and sufficient condition for the equations to be exact, Reducible to the exact differential equations. **14hrs**

Unit II: Differential equations of the first order and higher degree: Equations solvable for *p, x, y*. Clairaut's equation and singular solution. Orthogonal trajectories of Cartesian and polar curves. **14hrs**

Unit III: Linear differential equations of the n^{th} order with constant coefficients. Particular Integrals when the RHS is of the form e^{ax}, $\sin(ax+b)$, $\cos(ax+b)$, x^n, $e^{ax}V$ where V is a function of x. **14 hrs**

Reference Books:

1. M. D. Raisinghania, *Ordinary Differential Equations & Partial Differential Equations*, S. Chand & Company, New Delhi, 20th Edition – 2020. (For Unit I and Unit II)
2. J. Sinha Roy and S Padhy : *Acourse of Ordinary and Partial Differential Equation,* Kalyani Publishers, New Delhi, 4th Edition - 2014.
3. D. Murray, *Introductory Coursein Differential Equations*, Orient BlackSwan–2016.
4. W. T. Reid, *Ordinary Differential Equations,* John Wiley, New York - 1971.
5. S. L. Ross, *Differential Equations,* John Wiley and Sons, 3rd Edition -1984.

Open Elective Course

(For students of other than Science stream)

MATOET 3.1(B): Quantitative Mathematics	
Teaching Hours : 3 Hours/Week	**Credits: 3**
Total Teaching Hours: 42 Hours	**Max. Marks: 100 (SEE - 60 + IA - 40)**

Course Outcomes: This course will enable the students to:

- Understand number system and fundamental operations
- Understand the concept of linear quadratic and simultaneous equations and their applications in real life problems
- Understand and solve the problems based on Age.
- Solve Speed and Distance related problems.

Unit-I: Algebra

Set theory and simple applications of Venn Diagram, relations, functions, indices, logarithms, permutations and combinations. Examples on commercial mathematics.

14 Hrs

Unit-II: Number System

Numbers, Operations on Numbers, Tests on Divisibility, HCF and LCM of numbers. Decimal Fractions, Simplification, Square roots and Cube roots - Problems thereon. Surds and Indices. Illustrations thereon.

14 Hrs

Unit-III: Theory of equations

Linear equations, quadratic equations, simultaneous equations in two variables, simple application problems - Problems on Ages, Problems on conditional Age calculations, Present & Past age calculations. 14 Hrs

Reference Books:

1. R.S. Aggarwal, *Quantitative Aptitude*, S. Chand and Company Limited, New Delhi -2021.
2. Abhijit Guha, *Quantitative Aptitude*, Mc.Grawhill publications, 5thEdition - 2014.
3. R. V. Praveen, *Quantitative Aptitude and Reasoning*, PHI publishers, 3rd Edition – 2016.
4. R. S. Aggarwal, *Objective Arithmetic*, S. Chand & Company Ltd, Revised Edition – 2018.
5. Qazi Zameeruddin,Vijay K. Khanna, S. K. Bhambri, *Business Mathematics, S. Chand* publications, 2nd*Edition - 2009*

6. S. K. Sharma and Gurmeet Kaur, *Business Mathematics*, Sultan Chand & Sons – 2019.
7. Hazarika Padmalochan, *A Text Book of Business mathematics for B.Com and BBA Course,* S. Chand Publication - 2017
8. N. G. Dasand, J. K. Das, *Business Mathematics and Statistics,* Mc.Grawhill Education - 2017.

Open Elective Course

(For Students of other than Science Stream)

MATOET 3.1(C): Vedic Mathematics	
Teaching Hours : 3 Hours/Week	**Credits: 3**
Total Teaching Hours: 42 Hours	**Max. Marks: 100(S.A.- 60 + I.A. – 40)**

Course Outcomes: This course will enable the students to:

- Understand the Vedic methods of arithmetic
- Understand the Vedic methods of division with two/three digit divisor
- Understand the Vedic methods of power and root power of two digit numbers

Unit-I: Multiplication:

1. Ekadhikenpurven method (multiplication of two numbers of two digits).
2. Eknunenpurven method (multiplication of two numbers of three digits).
3. Urdhvatiragbhyam method (multiplication of two numbers of three digits).
4. Nikhilam Navtashchramam Dashtaha (multiplication of two numbers of three digits).
5. Combined Operations. **14 Hours**

Unit-II: Division and Divisibility

Part A: Division

1. NikhilamNavtashchramamDashtaha (two digits divisor)
2. ParavartyaYojyet method (three digits divisor)

Part B:Divisibility

1. Ekadhikenpurven method (two digits divisor)
2. Eknunenpurven method (two digits divisor) **14 Hours**

Unit-III:

Power and Root Power:

1. Square (two digit numbers)
2. Cube (two digit numbers).

Root:

1. Square root (four digit number)
2. Cube root (six digit numbers).
3. Solution of linear simultaneous equations. **14 Hours**

Reference Books:

1. *Vedic Mathematics*, **Motilal Banarsidass Publishers,** NewDelhi -1990
2. *Vedic Ganita*: Vihangama Drishti-1,SikshaSanskriti Uthana Nyasa,NewDelhi.
3. *Vedic Ganita Praneta*, Siksha Sanskriti Uthana Nyasa, NewDelhi.
4. *Vedic Mathematics:Past, Present and Future*, Siksha Sanskriti Uthana Nyasa,NewDelhi.
5. Leelavati, Chokhambba Vidya Bhavan, Varanasi.
6. *Bharatiya Mathematicians*, Sharda Sanskrit Sansthan, Varanasi.

SEMESTER – IV

MATDSCT 4.1: Partial Differential Equations and Integral Transforms	
Teaching Hours: 4 Hours/Week	**Credits: 4**
Total Teaching Hours: 56 Hours	**Max. Marks: 100 (SEE - 60 + I.A. – 40)**

Course Learning Outcomes: This course will enable the students to

- Solve the Partial Differential Equations of the first order and second order
- Formulate, classify and transform partial differential equations into canonical form.
- Solve linear and non-linear partial differential equations using various methods; and apply these methods to solving some physical problems.
- Able to take more courses on wave equation, heat equation, and Laplace equation.
- Solve PDE by Laplace Transforms and Fourier Transforms

Unit I: Basic concepts–Formation of a partial differential equations by elimination of arbitrary constants and functions, Solution of partial differential equations – Solution by Direct integration, Lagrange's linear equations of the form $Pp + Qq = R$, Standard types of first order non-linear partial differential equations, The integrals of the non-linear equation by Charpit's method. **14 Hrs**

Unit II: Homogeneous linear partial differential equations with constant coefficients. Partial differential equations of the second order. Classification of second-order partial differential equations, canonical forms. Classification of second order linear equations as hyperbolic, parabolic, and elliptic. Solutions of the Heat equation, Laplace equation and Wave equation (using separation of variables). **14 Hrs**

Unit III: Laplace Transforms: Definition**,** Basic Properties. Laplace transforms of some standard functions. Laplace transform of Periodic functions. Laplace transform of derivative and integral of a function. Heaviside function. Dirac-delta function. Convolution theorem. Inverse Laplace transforms and its properties. Solution of differential equations by using Laplace transforms. **14 Hrs**

Unit IV: Fourier Series and Transforms: Periodic functions. Fourier Coefficients. Fourier series of functions with period 2 and period 2L. Fourier series of even and odd functions. Half range Cosine and Sine series. Fourier Transforms - Finite Fourier Cosine and Sine transform. Transforms of derivates**.** Applications of Fourier Transforms**.** **14 Hrs**

Reference Books:

1. D. A. Murray, *Introductory Course in Differential Equations,* Orient and Longman - 2017
2. H. T. H. Piaggio, *Elementary Treatiseon Differential Equations and their Applications,* CBS Publisher & Distributors, Delhi - 1985.
3. G. F. Simmons, *Differential Equations,* Tata McGrawHill, 1st Edition – 2006.
4. S. L. Ross, *Differential Equations*, JohnWileyand Sons, India, 3rdEdition -2004.
5. M. D. Raisinghania, *Ordinary Differential Equations & Partial Differential Equations*, S. Chand & Company, New Delhi, 20th Edition - 2020

6. K. Sankara Rao, *Introductionto Partial Differential Equations*, PHI, 3rdEdition -2015.
7. Ion N. Sneddon, *Elements of Partial differential equations*, McGraw-Hill International Editions -1986.
8. R. Murray and L. Spiegal (Schaum's Series), *Laplace Transforms,* McGraw Hill Education – 2005.
9. J. K. Goyal and K. P. Gupta, *Laplace and Fourier Transforms*, Pragathi Prakashan – 2016.
10. Sudhir Kumar, *Integral Transform Methods in Science & Engineering*, CBS Engineering Series - 2017.
11. Earl David Rainville and Philip Edward Bedient, *Ashortcoursein Differential Equations*, Prentice Hall College Div, Pearson College Div, 6th edition - 1981.
12. Sathya Prakash, *Mathematical Physics with classical Mechanics*, S Chand and Sons, New Delhi -2014

PRACTICALS

MATDSCP 4.1: Practical's on Partial Differential Equations and Integral Transforms	
Practical Hours : 4 Hours/Week	**Credits: 2**
Total Teaching Hours: 56 Hours	**Max. Marks: 50 (S.A.-25 + I.A. – 25)**

Mathematics practical with Free and open Source Software (FOSS) tools for computer programs

Course Learning Outcomes: This course will enable the students to

- Learn Free and Open Source software (FOSS) tools or computer programming.
- Solve problems on Partial Differential Equations and Integral Forms
- To find Laplace transform of various functions
- To find the Fourier Transform of periodic functions
- To solve differential equations by using Integral transforms.

Programs using Scilab/Maxima/Python:

Elements of Partial differential equations and Integral transforms using FOSS

1 Solutions of Linear Partial differential equations of type1 to type4 and Lagrange's method
2 Solutions of partial differential equation using Charpit's method.
3 Solutions of Second order homogenous partial differential equation with constant coefficients.
4 Solutions to the partial differential equations using separation of variables method (Heat/ Wave/Laplace).
5 Finding the Laplace transforms of some standard and periodic functions.
6 Finding the inverse Laplace transform of simple functions
7 Verification of Convolution Theorem.
8 To solve ordinary linear differential equation using Laplace transform.
9 To solve Integral equation using Laplace transform.
10 To find full range Fourier series of some simple functions with period 2 and 2L
11 To find Half range sine and cosine series of some simple functions and ploting them.
12 To find Cosine Fourier transforms.
13 To find Sine Fourier transforms.

Open Elective Course

(For students of Science stream who have not chosen Mathematics as one of the Core Course)

MATOET4.1(A): Partial Differential Equations	
Teaching Hours: 3 Hours/Week	**Credits: 3**
Total Teaching Hours: 42 Hours	**Max. Marks: 100 (SEE-60 + I.A. – 40)**

Course Learning Outcomes: This course will enable the students to

- Explain the concept of the differential equation.
- Classifies the differential equations concerning their order and linearity.
- Explains the meaning of the solution of a differential equation.
- Solve first-order ordinary differential equations.
- Solves exact differential equations and Converts separable and homogenous equations to exact differential equations by integrating factors.
- Solves Bernoulli differential equations.
- Will be able to find the solution to higher-order linear differential equations.

Unit I: Basic concepts–Formation of a Partial differential equations by elimination of arbitrary constants and functions – Solution of partial differential equations – Solution by Direct integration, Lagrange's linear equations of the form $Pp + Qq = R$. **14 Hrs**

Unit II : Standard types of first order non-linear partial differential equations, The integrals of the non-linear equation by Charpit's method. Homogeneous Linear partial differential equations with constant coefficients. Partial differential equations of the second order. Classification of second- order partial differential equations, canonical forms.

15 Hrs

Unit III: Classification of second order linear equations as hyperbolic, parabolic, and elliptic. Solutions of the Heat equation, Laplace equation and Wave equation (using separation of variables). **14 Hrs**

Reference Books:

1. D. A. Murray, *Introductory Course in Differential Equations,* Orient and Longman - 2017
2. H. T. H. Piaggio, *Elementary Treatiseon Differential Equations and their Applications,* CBS Publisher & Distributors, Delhi - 1985.
3. G. F. Simmons, *Differential Equations,* Tata McGrawHill, 1st Edition – 2006.
4. S. L. Ross, *Differential Equations*, JohnWileyand Sons, India, 3rdEdition -2004.
5. M. R. Speigel, *Schaum's outline of Laplace Transforms* – 2005.
6. M. D. Raisinghania, *Ordinary Differential Equations & Partial Differential Equations*, S. Chand & Company, New Delhi, 20th Edition - 2020
7. K. Sankara Rao, *Introductionto Partial Differential Equations*, PHI, 3rdEdition -2015.
8. Ion N. Sneddon, *Elements of Partial differential equations*, McGraw-Hill International Editions -1986.

Open Elective Course

(For students of other than science stream)

MATOET4.1(B) : Mathematical Finance	
Teaching Hours: 3Hours/week	**Credits: 3**
Total Teaching Hours:42Hours	**Max.Marks:100 (S.A-60+I.A.-40)**

Course Learning Outcomes: This course will enable the students to

- Understand how compute profit and loss, discount and Banker's discount.
- Understand the concept of Linear equations and inequalities and their use in the solving the Linear Programming Problems.
- Formulation of Transportation Problem and its application in routing problem.

Unit-I: Commercial Arithmetic

Bill of exchange, Bill of discounting procedure. Basic formula related to profit, loss, discount and brokerage, Successive discount, True discount, Banker's discount.

14 Hrs

Unit-II: Linear Programming

Linear equations and inequalities- Rectangular coordinates, straight line, parallel and intersecting lines and linear inequalities, Introduction to linear programming, Mathematical formulation of LPP, Solution of a LPP by graphical method, special cases in graphical method

14 Hrs

Unit-III: Transportation problem

Introduction, Formulation of Transportation problem, Initial basic feasible solution, Steps involving a transportation problem, optimality check, special cases in Transportation problem. The Traveling salesman Problem (Routing Problem). **14 Hrs**

Reference Books:

1. R. S. Aggarwal, *Objective Arithmetic*, S. Chand & Company Ltd, Revised Edition - 2018.
2. Mizrahiand Sullivan, *Mathematics for Business and Social Sciences an Applied approach,* John Wiley & Sons – 1976.
3. Qazi Zameeruddin,Vijay K Khanna, S K Bhambri, *Business Mathematics,* Vikas Publishing House, 2nd Edition.
4. S. Kalavathy, *Operation Research*, Vikas publication house Pvt. Ltd, 4th Edition – 2013.
5. Sreenivasa Reddy M, *Operations Research*, Sanguine Technical publishers, Bangalore, 2nd edition – 2019.
6. S. D. Sharma, *Operation Research*, 20th Edition – 2014.

Open Elective Course

(For students other than science stream)

MATOET 4.1 (C): Mathematics for Social Sciences	
Teaching Hours : 3 Hours/Week	**Credits: 3**
Total Teaching Hours: 42 Hours	**Max. Marks: 100 (S.A.- 60 + I.A. – 40)**

Course Learning Outcomes: This course will enable the students to

- Understand the mathematical concept of sets and counting problems.
- Understand the concept of Probability and its applications in social sciences.
- Understand the concept of limits and continuity of functions and its applications in business and

social sciences.

Unit-I

Sets, counting, permutations, combinations, counting problems, binomial theorem and problems thereon. Probability – Introduction, sample space and assignment of probabilities, properties of the probability of an event, probability of equally likely events, conditional probability, Baye's formula and examples thereon.

14 Hours

Unit-II

Limit and continuity, Derivative- interpretation, derivative formulas, general derivatives for differentiation, composit functions, higher order derivaties and problems thereon.

14 Hours

Unit-III

Applications of the derivative – Relative maxima and Relative minima, Absolute maximum and Absolute minimum, Applied problems, Concavity, Asymptotes, Marginal analysis, Models- Maximizing tax revenue, Otimal trade-in time, and minimizing inventory cost.

14 Hours

REFERENCE BOOKS

1. Abe Mizrahi and Michael Sullivan, *Mathematics for Business and Social Sciences and Applied Approach,* John Wiley & Sons, 4th Edition - 1988.
2. Carl P. Simon and Lawrence Blume*, Mathematics for Economists,* Viva Books Private Limited, New Delhi - 2018.
3. L. Peccati, M. D'Amico and M. Cigola*, Maths for Social Sciences,* Springer – 2018.

Question Paper Pattern

Mathematics

(Major subject)

PART –A
Answer any **TEN** questions (10 x 2 = 20) • Total number of questions: 14 • Atleast 3 questions to be framed from each unit
PART – B
Answer any 8 questions by choosing two questions from each unit (5 marks each) 8 x 5 = 40 **UNITWISE (4 questions from each unit)**

(Open Elective)

PART –A
Answer any **TEN** questions (10 x 2 = 20) • Total number of questions: 12 • 4 questions from each unit
PART – B
Answer any 6 questions by choosing two questions from each unit (6 marks each) 6 x 5 = 36 **UNITWISE (4 questions from each unit)**

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SYLLABUS

V and VI Semester
B.A./B.Sc. (Hons) Mathematics,

(ACCORDING TO NATIONAL EDUCATION POLICY 2020)

2023

Name of the Degree Program : **B.A./B.Sc.**
Discipline Course : **Mathematics**
Starting Year of Implementation : **2021-22 (I & II Semesters)**
2022-23 (III & IV Semesters)
2023-24 (V & VI Semesters)

Assessment

Weightage for the Assessments (in percentage)

Type of Course	Formative Assessment/ I.A.	Summative Assessment (S.A.)
Theory	40%	60 %
Practical	50%	50 %
Projects	40 %	60 %
Experiential Learning (Internship etc.)	--	--

Courses Offered

Semester	Course No.	Theory/ Practical	Credits	Paper Title	Marks in percentage	
					S. A.	I.A.
V	MATDSCT5.1	Theory	4	Real Analysis-II and Complex Analysis	60	40
	MATDSCP5.1	Practical	2	Theory based Practicals on Real Analysis-II and Complex Analysis	25	25
	MATDSCT5.2	Theory	4	Algebra and Graph Theory	60	40
	MATDSCP5.2	Practical	2	Theory based Practicals on Algebra and Graph Theory	25	25
VI	MATDSCT6.1	Theory	4	Linear Algebra	60	40
	MATDSCP6.1	Practical	2	Theory based Practicals on Linear Algebra	25	25
	MATDSCT6.2	Theory	4	Numerical Analysis	60	40
	MATDSCP6.2	Practical	2	Theory based Practicals on Numerical Analysis	25	25

Syllabus for B.A./B.Sc. with Mathematics

SEMESTER – V

MATDSCT 5.1: Real Analysis-II and Complex Analysis	
Teaching Hours : 4 Hours/Week	**Credits: 4**
Total Teaching Hours: 60 Hours	**Max. Marks: 100 (S.A.-60 + I.A. – 40)**

Course Learning Outcomes:

The overall expectation from this course is that the student builds a basic understanding on Riemann integration and elementary complex analysis. The broader course outcomes are listed as follows. At the end of this course, the student will be able to:

1. Carry out computations of upper and lower Riemann sums as well definite integrals.
2. Describe various criteria for Integrability of functions.
3. Evaluate some improper integrals and Evaluate double integrals by using Beta, Gamma functions.
4. Exhibit certain properties of mathematical objects such as integrable functions, analytic functions, harmonic functions and so on.
5. Prove some statements related to Riemann integration as well as in complex analysis.
6. Carry out the existing algorithms to construct mathematical structures such as analytic functions.
7. Evaluate complex line integrals using definition and some well known theorems.
8. Apply the gained knowledge to solve various other problems.

Real Analysis-II

Unit – I: Riemann Integration

Definition and Existence of the Integral, Riemann Darboux Sums - Upper and lower (Darboux) sums - definition, properties and problems. Riemann Integral - Upper and Lower integrals (definition & problems), Inequalities for Integrals, Refinement of Partitions, Darboux's theorem, Conditions of Integrability, Integrability of Sum, Difference, Product, Quotient and Modulus of integrable functions. Integral as a limit of sum (Riemann sums), Some Applications, Some Integrable Functions – Integrability of continuous functions, monotonic functions, bounded function with finite number of discontinuity.

15 Hour

Unit –II: Improper Integrals

Improper integrals of the first, second and third kind with examples. Improper integral as the limit of the proper integral. Comparison test, Abel's test and Dirichlet's test for the convergence of the integral of a product of two functions. Beta, Gamma functions - Definitions, properties and examples, Relations between Beta and Gamma functions, Applications to evaluation of definite integrals, Duplication formula and applications.

15 Hours

Complex Analysis

Unit – III: Complex numbers and functions of complex variables:

Complex numbers: Sums and Products, Basic Algebraic Properties, Further Properties, Vectors and Moduli, Complex Conjugates, Exponential Form, Products and Powers in Exponential Form, Arguments of Products and Quotients, Roots of Complex Numbers, and examples, Regions in the complex plane.

Analytic Functions: Functions of a Complex Variable, Mappings, Mappings by the Exponential Function, Limits, Theorems on Limits, Limits Involving the Point at Infinity, Continuity, Derivatives, Differentiation Formulas, Cauchy–Riemann Equations, Sufficient Conditions for Differentiability, Polar Coordinates, Analytic Functions and examples, Harmonic Functions.

15 Hours

Unit –IV: Complex Integration

Derivatives and Definite Integrals of Complex valued Functions of Real Variable, Contours, and Contour Integrals with Examples, Examples with Branch Cuts, Upper Bounds for Moduli of Contour Integrals, Antiderivatives, Cauchy–Goursat Theorem, Simply Connected Domains, Multiply Connected Domains, Cauchy Integral Formula, An Extension of Cauchy Integral Formula, Some Consequences of the Extension.

15 Hours

Reference Books:

[1] S.C. Malik and Savita Arora, *Mathematical Analysis*, 2nd ed. New Delhi, India: New Age international (P) Ltd.

[2] Maurice D. Weir, George B. Thomas, Jr., Joel Hassand Frank R. Giordano, Thomas' Calculus, 11th Ed., Pearson, 2008.

[3] R.V. Churchil & J.W. Brown, *Complex Variables and Applications*, 5th ed, McGraw Hill Companies.

[4] S.C Malik, *Real Analysis,* New Age International (India) Pvt. Ltd.

[5] Richard R Goldberg, *Methods of Real Analysis*, Oxford and IBH Publishing.

[6] Ajit Kumar and S. Kumaresan - *A Basic Course in Real Analysis*, Taylor and Francis Group.

[7] L. V. Ahlfors, *Complex Analysis*, 3rd Edition, McGraw Hill Education.

[8] Bruce P. Palka *, Introduction to the Theory of Function of a Complex Variable*, Springer

[9] Serge Lang, *Complex Analysis*, Springer.

[10] Shanthinarayan, *Theory of Functions of a Complex Variable,* S. Chand Publishers.

[11] S. Ponnuswamy, *Foundations of Complex Analysis*, 2nd Edition, Alpha Science International Limited.

[12] Grewal, B. S., & Grewal, J. S. (1996). Higher engineering mathematics. 42nd Ed., Khanna Publishers, New Delhi.

[13] Shanthi Narayan, P. K. Mittal (2004), Theory of Functions of a Complex Variable, Revised Ed. S. Chand and Company Ltd. New Delhi.

MATDSCP 5.1: Practicals on Real Analysis-II and Complex Analysis	
Practical Hours : 4 Hours/Week	**Credits: 2**
Total Practical Hours: 60 Hours	**Max. Marks: 50 (S.A.-25 + I.A. – 25)**

Course Learning Outcomes: This course will enable the students to

1. Learn *Free and Open Source Software* (FOSS) tools for computer programming
2. Solve problem on Real Analysis and Complex Analysis studied in MATDSCT 5.1 by using FOSS softwares.
3. Acquire knowledge of applications of Real Analysis and Complex Analysis through FOSS.

Practical/Lab Work to be performed in Computer Lab

Suggested Software: Maxima/Scilab/Python/R.
Suggested Programs:

1. Program to find upper and lower Riemann sums with respect to given partition
2. Program to test Riemann Integrability.
3. Program to evaluate Riemann integral as a limit of sum.
4. Program to check the convergence of the given improper integral using Abel's test.
5. Program to check the convergence of the given improper integral using Dirichlet's test.
6. Programs to evaluate improper integrals using Beta/Gamma Functions.
7. Program to illustrate applications of duplication formula for Beta/Gamma functions.
8. Program to find the nth roots of a given complex number.
9. Program on verification of Cauchy – Riemann equations (Cartesian form) or test for analyticity.
10. Program on verification of Cauchy – Riemann equations (Polar form) or test for analyticity.
11. Program to check whether a function is harmonic or not.
12. Program to construct analytic functions (through Milne–Thompson method).
13. Program to evaluate Definite Integrals of Complex valued Functions of Real Variable.
14. Program to illustrate evaluation of integrals using Cauchy's integral theorem.

MATDSCT5.2: Algebra and Graph Theory	
Teaching Hours : 4 Hours/Week	**Credits: 4**
Total Teaching Hours: 60 Hours	**Max. Marks: 100 (S.A.-60 + I.A. – 40)**

Course Learning Outcomes: The overall expectation from this course is that the student builds a basic understanding on the theory of groups and some elementary concepts of graph theory. This course will enable the students to:

1. Know the significance of normal subgroups and quotient groups.
2. Understand structure preserving mapping between two algebraic structures of the same type.
3. Know the algebraic structures having the same structure with different elements.
4. Identify and analyze the algebraic structures such as ring, field and integral domain
5. Know the basic terminologies used in the theory of graphs.
6. Study the graphs which are used to model pair wise relations between the objects which will help in understanding the networking, optimization, matching and operation.
7. Understand the importance of cutsets, connectivity, planarity and colorability in the theory of graphs.
8. Apply graph theoretic tools to solve real life problems.

Algebra

Unit I: More on Groups

Congruence relation in subgroups, Cosets, Theorem on cosets, Lagrange's theorem and applications, Index of a subgroup, Normal Subgroups, Quotient groups. Homomorphism, Kernel of a homomorphism, Isomorphism, First Isomorphism theorem, Automorphisms. Permutation groups, Cycles, Transpositions, Type of permutations, Length of a cycle, Index of S_n, Alternating group, Order of a permutation.

15 hours

Unit II: Rings, Integral Domains, Fields

Rings : Definition and examples, Commutative Rings, Subrings, Integral Domain, Division Ring, Fields, Properties of Rings, Characteristic of an Integral Domain, Homomorphism, Kernel, Isomorphism, Ideals, First Isomorphism theorem in Rings, Prime and Maximal Ideals, Quotient Rings.

15 hours

Graph Theory

Unit III: Basics of Graph Theory

Graphs, Finite and infinite graphs, Incidence and degree, Isolated vertex, Pendent vertex, Null graph, Isomorphism, Sub graph, Walks, Paths, Circuits, Connected and Disconnected graphs, components, Euler graphs, Operation on graphs, Hamiltonian paths, Circuits, Tees and some properties of trees, Rooted and Binary trees, Spanning tree and Fundamental circuit.

15 hours

Unit IV: Connectivity, Planar Graphs and Coloring

Cutsets, Properties, Fundamental cut sets, Connectivity, and Separability. Planar graphs, Kuratowski's graphs, Different representation of planar graphs, Geometric duel. Graph Coloring: Chromatic number and Chromatic polynomials.

15 hours

Reference Books

[1] I N Herstein (1990), Topics in Algebra, 2nd Edition, Wiley Eastern Ltd., New Delhi.

[2] Vijay K Khanna and S K Bhambri (1998), A Course in Abstract Algebra, Vikas Publications.

[3] Michael Artin (2015), Algebra, 2nd ed., Pearson.

[4] Joseph A, Gallian (2021), Contemporary Abstract Algebra, 10th ed., Taylor and Francis Group.

[5] C. L. Liu (2000), Elements of Discrete Mathematics, Tata McGraw-Hill.

[6] Hari Kishan and Shiv Raj Pundir (2015), Discrete Mathematics, Pragathi Prakashan, 10th ed.

[7] W D Wallis (2017), A Beginner's Guide to Discrete Mathematics for Computer Science, Wiley Publishers.

[8] Kenneth H. Rossen, Discrete Mathematics and its Applications, Mc-Graw Hill, 8th ed., 2021.

[9] Frank Harary (1969), Graph Theory, Addison-Wesley Pub. Company.

[10] N. Deo (1990), Graph Theory: Prentice Hall of India Pvt. Ltd. New Delhi.

[11] D B West (2001), Introduction to graph theory 2nd Ed., Pearson.

MATDSCP5.2: Practicals Algebra and Graph Theory	
Teaching Hours : 4 Hours/Week	**Credits: 2**
Total Teaching Hours: 60 Hours	**Max. Marks: 50** **(S.A.-25 + I.A. – 25)**

Course Learning Outcomes: This course will enable the students to

1. Learn *Free and Open Source Software (FOSS)* tools for computer programming
2. Solve problems related to Algebra and Graph Theory using FOSS software.

Practical/Lab Work to be performed in Computer Lab (FOSS) Suggested Software: Maxima/Scilab /Python/R.

Suggested Programs:

1. Verification of Lagrange's theorem
2. Examples to find left and right cosets and finding index of a group
3. Finding all Normal Subgroups of a group.
4. Finding whether a given Permutation is even and odd and its order.
5. Checking whether a given set is a ring with respect to given binary operations.
6. Checking whether a given set is an integral domain or field with respect to given binary operations.
7. Finding zero divisors and units in finite rings.
8. Verification of the given mapping for ring homomorphism.
9. Drawing some standard graphs like Dodecahedron, wheel graph, Peterson graph.
10. Checking planarity, finding number of edges, vertex and edge connectivity, center, radius, and diameter.
11. Checking for Hamiltonian path/circuit in a graph.
12. Checking for Eulerian path/cycle in a graph.
13. Finding shortest path between two vertices.
14. Finding vertex coloring and redrawing the graph with colouring for vertices and finding chromatic number.

SEMESTER – VI

MATDSCT 6.1: Linear Algebra	
Teaching Hours : 4 Hours/Week	**Credits: 4**
Total Teaching Hours: 60 Hours	**Max. Marks: 100 (S.A.-60 + I.A. – 40)**

Course Learning Outcomes:

The overall expectation from this course is that the student will build a basic understanding in few areas of linear algebra such as vector spaces, linear transformations and inner product spaces. Some broader course outcomes are listed as follows. At the end of this course, the student will be able to

1. Understand the concepts of Vector spaces, subspaces, bases dimension and their properties.
2. Find a basis and compute the dimension of a given finite dimensional vector space.
3. Use matrix representation of linear transformations in various computations.
4. Become familiar with the concepts Eigen values and Eigen vectors, minimal polynomials, linear transformations etc.
5. Learn properties of inner product spaces and determine orthogonality in inner product spaces.
6. Prove various statements in the context of vectors spaces.
7. Realize importance of adjoint of a linear transformation and its canonical form.
8. Apply the techniques of diagonalization in solving various problems related to matrices.

Unit – I: Vector spaces

Vector spaces - Definition, Examples and properties, Subspaces - Examples, Criterion for a sub- set to be a subspace and some properties. Linear Combination - Linear span, Linear dependence and Linear independence, Basic properties of linear dependence and independence, Techniques of determining linear dependence and independence in various vector spaces and related problems. Basis and dimension - Co-ordinates, Ordered basis, Some basic properties of basis and dimension and subspace spanned by given set of vectors, Quotient space, Dimension of quotient space (derivation in finite case). Sum and Direct sum of subspaces - Dimensions of sum and direct sum spaces (derivation in finite case).

15 Hours

Unit – II: Linear Transformations

Linear transformation - Definition, Examples, Equivalent criteria, Some basic properties, Matrix representation, Change of basis and effect on associated matrix, Similar matrices; Rank - Nullity theorem - Null space, Range space, Proof of rank nullity theorem and related problems.

15 Hours

Unit – III: Isomorphism, Eigenvalues and Diagonalization

Homomorphism, Isomorphism and automorphism - Examples, Order of automorphism and Fundamental theorem of homomorphism; Eigenvalues and Eigen vectors - Computation of eigen values, Algebraic multiplicity and some basic properties of eigen values, Determination of eigenvectors and eigen space and geometric multiplicity. Diagonalizability of linear transformation - Meaning, Condition based on algebraic and geometric multiplicity and related problems.

15 Hours

Unit – IV: Invertible Transformation and Inner product spaces

Invertible transformation - Some basic properties of invertible, singular and non-singular transformations, Conditions for existence of inverses, Minimal polynomial of a transformation**,** Relation between characteristic and minimal polynomials and related problems.

Inner product and normed linear spaces - Definitions, Examples, Cauchy-Schwartz inequality and related problems; Gram-Schmidt orthogonalization - Orthogonal vectors, orthonormal basis, Gram-Schmidt orthogonalization process.

15 Hours

Reference Books:

[1] I. N. Herstein, *Topics in Algebra*, 2nd Edition, Wiley.

[2] Stephen H. Friedberg, Arnold J. Insel & Lawrence E. Spence (2003), Linear Algebra(4^{th} Edition), Printice-Hall of India Pvt. Ltd.

[3] F. M. Stewart, *Introduction to Linear Algebra*, Dover Publications.

[4] S. Kumaresan, *Linear Algebra*, Prentice Hall India Learning Private Limited.

[5] Kenneth Hoffman & Ray Kunze (2015), Linear Algebra, (2^{nd} Edition), PrenticeHall India Leaning Private Limited.

[6] Gilbert Strang (2015), Linear Algebra and its applications, (2^{nd} Edition), Elsevier.

[7] Vivek Sahai & Vikas Bist (2013), Linear Algebra (2^{nd} Edition) Narosa Publishing.

[8] Serge Lang (2005), Introduction to Linear Algebra (2^{nd} Edition), Springer India.

[9] T. K. Manicavasagam Pillai and K S Narayanan, Modern Algebra Volume 2.

MATDSCP 6.1: Practicals on Linear Algebra	
Practical Hours : 4 Hours/Week	**Credits: 2**
Total Practical Hours: 60 Hours	**Max. Marks: 50 (S.A.-25 + I.A. – 25)**

Course Learning Outcomes: This course will enable the students to

1. Learn *Free and Open Source Software (FOSS)* tools for computer programming
2. Solve problem on Linear Algebra studied in MATDSCT 6.1 by using FOSS softwares.
3. Acquire knowledge of applications of Linear Algebra through FOSS.

Practical/Lab Work to be performed in Computer Lab (FOSS) Suggested Softwares: Maxima/Scilab /Python/R.

Suggested Programs:

1. Program to verify linear dependence and independence.
2. Program to find basis and dimension of the subspaces.
3. Program to verify if a function is linear transformation or not.
4. Program to find the matrix of linear transformation.
5. Program to illustrate the effect of change of basis on the matrix of linear transformation.
6. Program to check invertibility of the given linear transformation and finding the inverse if exists.
7. Program to find the Eigen values and Eigen vectors of a given linear transformation.
8. Program on Rank – nullity theorem.
9. Program to find the characteristic polynomial of given transformation.
10. Program to find the minimal polynomial of given transformation.
11. Program to find the algebraic multiplicity of the Eigen values of the given linear transformation.
12. Program on diagonalization.
13. Program to verify that the given basis is orthogonal or not.
14. Program to illustrate Gram-Schmidt orthogonalization process.

MATDSCT 6.2: Numerical Analysis	
Teaching Hours : 4 Hours/Week	**Credits: 4**
Total Teaching Hours: 60 Hours	**Max. Marks: 100 (S.A.-60 + I.A. – 40)**

Course Learning Outcomes:

The overall expectation from this course is that the student will get equipped with certain numerical techniques for various computations such as finding roots, finding the integrals and derivatives, and finding solutions to differential equations. Some broader course outcomes are listed as follows. At the end of this course, the student will be able to

1. Compute approximate roots of algebraic and transcendental equations using iterations.
2. Describe various operators arising in numerical analysis such as difference operators, shift operators and so on.
3. Articulate the rationale behind various techniques of numerical analysis such as in finding roots, integrals and derivatives.
4. Reproduce the existing algorithms for various tasks as mentioned previously in numerical analysis.
5. Apply the rules of calculus and other areas of mathematics in justifying the techniques of numerical analysis.
6. Solve problems using suitable numerical technique.
7. Obtain approximate solutions to initial value problems using various numerical techniques.
8. Appreciate the profound applicability of techniques of numerical analysis in solving real life problems and also appreciate the way the techniques are modifiedto improve the accuracy.

Unit – I: Algebraic and Transcendental Equations

Solutions to algebraic and transcendental equations -Bisection method, Regula-Falsi method, Iterative methods, Newton-Raphson method and Secant method (Plain discussion of the rationale behind techniques and problems on their applications).

System of Linear Algebraic Equations: Direct Methods – Gauss elimination method, Gauss-Jordan elimination method and Tringularization method; Iterative methods – Jacobi method, Gauss-Jacobi method, Gauss- Seidal method.

15 Hours

Unit – II: Polynomial Interpolations

Finite differences - Forward, Backward differences and shift operators: definitions, properties and problems; Polynomial interpolation - Newton-Gregory forward and backward interpolation formulas, Gauss's Forward and backward interpolation formulas, Lagrange interpolation polynomial, Newton's divided differences and Newton's general interpolation formula (Discussion on setting up the polynomials and problems on their applications).

15 Hours

Unit-III: Numerical Differentiation and Integration

Formula for derivatives (till second order) based on Newton-Gregory forward and backward interpolations (Derivations and problems based on them). Numerical Integration - General quadrature formula, Trapezoidal rule, Simpson's 1/3 rule, Simpson's 3/8 rule (derivations for only general quadrature formula, trapezoidal rule and Simpson's $1/3^{rd}$ rule and problems on the applications of all formulas).

15 Hours

UNIT-IV: Numerical Solution of Ordinary Differential Equations

Introduction, Solution by Taylor's series method, Picard's method, Euler's method, Modified Euler's method, Runge-Kutta Methods, Predictor-Corrector Methods- Milne's method, Adam's Bashforth Method, Adam Moulton Method.

15 Hours

Reference Books :

1. S. S. Sastry, *Introductory methods of Numerical Analysis*, 5th Edition, PHI Learning Private Limited.
2. E. Isaacson and H. B. Keller, *Analysis of Numerical methods*, Dover Publications.
3. E Kreyszig, *Advanced Engineering Mathematics*, Wiley India Pvt. Limited.
4. B. S. Grewal, *Numerical Methods for Scientists and Engineers*, Khanna Publishers.
5. M. K. Jain, S. R. K. Iyengar and R. K. Jain, *Numerical Methods for Scientific and Engineering computation*, 4th Edition, New Age International
6. H. C. Saxena, *Finite Difference and Numerical Analysis,* S. Chand Publishers
7. B. D. Gupta, *Numerical Analysis*, Konark Publishers Pvt. Ltd.

MATDSCP 6.2: Practicals on Numerical Analysis	
Practical Hours : 4 Hours/Week	**Credits: 2**
Total Practical Hours: 60 Hours	**Max. Marks: 50 (S.A.-25 + I.A. – 25)**

Course Learning Outcomes: This course will enable the students to

1. Learn *Free and Open Source Software (FOSS)* tools for computer programming
2. Solve problem on numerical Analysis studied in **MATDSCT 6.2 by** using FOSS softwares.
3. Acquire knowledge of applications of Numerical Analysis through FOSS.

Practical/Lab Work to be performed in Computer Lab (FOSS)

Suggested Softwares: Maxima/Scilab /Python/R.

Suggested Programs:

1. Program to find root of an equation using Bisection, Regula-Falsi and Secant methods.
2. Program to find root of an equation using Newton-Raphson method.
3. Program to solve system of algebraic equations using Gauss-elimination method.
4. Program to solve system of algebraic equations using Gauss-Jordan method.
5. Program to solve system of algebraic equation using Gauss-Jacobi method.
6. Program to solve system of algebraic equation using Gauss-Seidel method.
7. Program to evaluate integral using Simpson's 1/3 and 3/8 rules.
8. Program to evaluate integral using Trapezoidal and Weddle rules
9. Program to find the sums of powers of successive natural numbers using Newton – Gregory technique.
10. Program to find differentiation at specified point using Newton-Gregory interpolation method.
11. Program to find the missing value of table using Lagrange method.
12. Program to find the solution of given initial value problem using Picard's method.
13. Program to find the solution of given initial value problem using Euler's method and Modified Euler's method.
14. Program to find the solution of given initial value problem using Runge-Kutta methods.

References

1. The Hundred-Page Machine Learning Book, Andriy Burkov, January 13, 2019.
2. Introduction to Machine Learning with Python: A Guide for Data Scientists 1st Edition by Andreas Müller, Sarah Guido, O'Reilly Media, November 15, 2016

List of Activities:

1. Introduction to Scikit, Numpy, Scipy and Tensor Flow
2. Linear Regression – Single Variable Linear Regression
3. Linear Regression – Multi Variable Linear Regression
4. Classification – Logistic Regression
5. Classification – Support Vector Machines (SVM)
6. Classification using Neural Networks
7. Unsupervised Learning – Principal Component Analysis (PCA)
8. Unsupervised Learning – K-Means Clustering