BANGALORE UNIVERSITY

Department of Mathematics
Jnanabharathi Campus
Bengaluru – 560 056

Syllabus for
Mathematics
Under-Graduate (UG) Programmme
I & II Semester

Framed according to the
National Education Policy (NEP 2020)

September 20, 2021

Proceedings of the BOS meeting in UG-Mathematics-Regular, held on 20th September 2021 in the Department of Mathematics, JB Campus, Bangalore University, Bangalore-560 056 at 2.00 pm

The following members attended the meeting to frame the NEP new syllabus for undergraduate degree program B.A./B.Sc with mathematics as Major Subject & B.A./B.Sc.(Hons) Mathematics.

1.	Prof. Harina P. Waghmore	Chairperson	
2.	Prof. Jayadeva. M	Member	
3.	Prof. T.R. Marulasiddappa	Member	
4.	Sri. Mahesh H.S	Member	
5.	Smt. Veena M.G	Member	
6.	Smt. Shobha. V	Member	
7.	Dr. Maheshwari P.G	Member	
8.	Dr. S. Sigarakanti	Member	
9.	Dr. R. Sumithra	Member	20/09/2021

The Chairperson thanked the members for their cooperation.

[Dr. HARINA P. WAGHAMORE]
CHAIRPERSON

Preamble

The subject wise expert committee to draft model curriculum contents in Mathematics constituted by the Department of Higher Education, Government of Karnataka, Bangalore vide GO No. ED 260 UNE 2019 (PART-1) DATED 13.08.2021 is pleased to submit its partial report on the syllabus for the First Year (First & Second Semesters) B.Sc.(Basic/Honors) Mathematics and detailed Course Structure for B.Sc.(Honors) Mathematics and M.Sc. (One Year) Mathematics.

The committee discussed various models suggested by the Karnataka State Higher Education Council in its joint meetings with the Chairpersons of Board of Studies of all state universities in Karnataka and resolved to adopt Model IIA (Model Program Structure for the Bachelor of Science (Basic/Hons.) for the subjects with practical's with Mathematics as Major/Minor.

To achieve the core objectives of the National Education Policy 2020 it is unanimously resolved to introduce computer based practical's for the Discipline Core (DSC) courses by using Free and Open Source Software's (FOSS) tools for implementation of theory based on DSC courses as it is also suggested by the LOCF committee that the papers may be taught using various Computer Algebra System (CAS) software's such as Mathematica, MATLAB, Maxima and R to strengthen the conceptual understanding and widen up the horizon of students' self-experience. In view of these observations the subject expert committee suggested the software's Python/ Maxima/ Scilab/ Maple/ MatLab/ Mathematica for hands on experience of implementation of mathematical concepts in computer based lab.

The expert committee suggests the implementation this curriculum structure in all the Departments of Mathematics in Universities/Colleges in Karnataka.

The subject expert committee designed the Course Learning Outcome (CO) to help the learners to understand the main objectives of studying the courses by keeping in mind of the Programme outcomes (PO) of the graduate degree with honors in Mathematics or a graduate degree with Mathematics as a major subject.

As the Mathematics subject is a vast with several branches of specializations, it is difficult for every student to learn each branch of Mathematics, even though each paper has its own importance. Hence the subject expert committee suggests number of elective papers (for both Discipline electives and Open

Electives) along with Discipline Core Courses. The BoS in Mathematics of universities may include additional electives based on the expertise of their staff and needs of the students'.

A student can select elective paper as per her/his needs and interest. The subject expert committee in Mathematics suggests that the concerned Department/Autonomous Colleges/Universities to encourage their faculty members to include necessary topics in addition to courses suggested by the expert committee.

B.Sc. Mathematics (Honors)

Programme Outcomes (PO): By the end of the program the students will be able to:

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 this 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 this 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 modeling ability, problem solving skills.
PO 5	**Research related skills:** The completing this programme 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 this programme will enable the learner to use appropriate softwares to solve system of algebraic equation and differential equations.
PO 7	**Self –directed learning**: The student completing this 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 this 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**: This programme provides self-directed learning and lifelong learning skills. This 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.Sc. with Mathematics as Major Subject & B.Sc.(Hons) Mathematics

Model IIA

Semester	Course No.	Theory/ Practical	Credits	Paper Title	Marks	
					S.A.	I.A.
I	MATDSCT1.1	Theory	4	Algebra - I and Calculus - I	60	40
	MATDSCP1.1	Practical	2	Theory based Practical's on 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	Algebra - II and Calculus - II	60	40
	MATDSCP2.1	Practical	2	Theory based Practical's on 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 Real Analysis-I	60	40
	MATDSCP3.1	Practical	2	Theory based Practical's on Ordinary Differential Equations and Real Analysis-I	25	25
	MATOET3.1	Theory	3	(A) Ordinary Differential Equations (B) Quantitative Mathematics	60	40
IV	MATDSCT4.1	Theory	4	Partial Differential Equations and Integral Transforms	60	40
	MATDSCP4.1	Practical	2	Theory based Practical's 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 Analysis and Complex Analysis	60	40
	MATDSCP5.1	Practical	2	Theory based Practical's on Real Analysis and Complex Analysis	25	25
	MATDSCT5.2	Theory	3	Ring Theory	60	40
	MATDSCP5.2	Practical	2	Theory based Practical's on Ring Theory	25	25
	MATDSET5.1	Theory	3	(A) Vector Calculus (B) Mechanics (C) Mathematical Logic	60	40
VI	MATDSCT6.1	Theory	3	Linear Algebra	60	40
	MATDSCP6.1	Practical	2	Theory based Practical's on Linear Algebra	25	25

	MATDSCT6.2	Theory	3	Numerical Analysis	60	40
	MATDSCP6.2	Practical	2	Theory based Practical's on Numerical Analysis	25	25
	MATDSET6.1	Theory	3	(A) Analytical Geometry in3D (B) Number Theory (C) Special Functions (D) History of Bhârtîya Gaṇita	60	40
Exit Option with Bachelor of Arts, B.A./ Bachelor of Science, B.Sc. Degree						
VII	MATDSCT7.1	Theory	3	Discrete Mathematics	60	40
	MATDSCP7.1	Practical	2	Theory based Practical's on Discrete Mathematics	25	25
	MATDSCT7.2	Theory	3	Advanced Ordinary Differential Equations	60	40
	MATDSCP7.2	Practical	2	Theory based Practical's on Advanced Ordinary Differential Equations	25	25
	MATDSCT7.3	Theory	4	Advanced Analysis	60	40
	MATDSET 7.1	Theory	3	(A) Graph Theory (B) Entire and Meromorphic Functions (C) General Topology (D) Bhâratîya Trikoṇmiti Śâstra	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	Advanced Partial Differential Equations	60	40
	MATDSCT8.3	Theory	3	Fuzzy Sets and Fuzzy Systems	60	40
	MATDSET 8.1	Theory	3	(A) Operations Research (B) Lattice theory and Boolean Algebra (C) Mathematical Modeling (D) *Aṅkapâśa* (Combinatorics)	60	40
	MATDSET 8.2	Research Project	6 (3 + 3)	Research Project* OR Any Two of the following electives (A) Finite Element Methods (B) Cryptography (C) Information Theory and Coding (D) Graph Theory and Networking	120 OR 60 60	80 OR 40 40

Award of Bachelor of Science Honours, B.Sc.(Hons) Degree in Mathematics

One Year M.Sc. degree in Mathematics (Two Semesters)						
Semester	**Course Number**	**Theory/ Practic al**	**Credits**	**Title of the Course**	**S.A.**	**I.A.**
I	PGMATDSCT1.1	Theory	3	C++ Programming for Mathematics	60	40
	PGMATDSCP1.1	Practical	2	Computer Practical's on C++ Programming for Mathematics	25	25
	PGMATDSCT1.2	Theory	3	Computational Numerical Methods	60	40
	PGMATDSCP1.2	Practical	2	Computer Practical's on CNM	25	25
	PGMATDSCT1.3	Theory	4	Functional Analysis	60	40
	PGMATDSET1.1	Theory	3	(A) Fluid Mechanics –I (B) Computational Fluid Mechanics (C) Contact Geometry (D) Fuzzy Topology (E) Ramanujan Theta Function and Continued Fractions	60	40
	PGMATDSET1.2	Theory	3	(A) Advanced Graph Theory (B) Partition Theory (C) Algebraic Number Theory (D) Riemannian Geometry	60	40
II	PGMATDSCT2.1	Theory	4	Measure Theory	60	40
	PGMATDSCT2.2	Theory	4	Differential Geometry	**60**	**40**
	PGMATDSCT2.3	Theory	3	Mathematical Methods	60	40
	PGMATDSET2.1	Theory	3	(A) Fluid Mechanics –II (B) Magneto hydrodynamics (C) Finsler Geometry and Relativity (D) Mathematical Modeling	60	40
	PGMATDSET2.2	Project	6	Research Project	120	80

- In lieu of the research Project, two additional elective papers/Internship may be offered

Abbreviation for MATDSCT1.1 /MATDSCP1.1

MAT – Mathematics ; DSC – Discipline Core; T – Theory/ P – Practical; 1 – First Semester; .1 – Course 1

PGMATDSCT1.1 : PG- Post Graduate ; MAT- Mathematics; DSC- Discipline Core; T- Theory 1 –First Semester; .1 – Course 1

CURRICULUM STRUCTURE FOR UNDERGRADUATE DEGREE PROGRAM

Name of the Degree Program : 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	-	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	-----	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	ASSIGNMENTS	
VI	MATDSCT6.1	PO 6, PO 7, PO 10.	MATDSCT5.2	GROUP DISCUSSION	
VI	MATDSCT6.2	PO 3, PO 4, PO 5, PO 8, PO 9, PO 10.	MATDSCT1.1 & MATDSCT2.1		TERM END EXAM
VII	MATDSCT7.1	PO 3, PO 4, PO5, PO 7, PO 9.	MATDSCT1.1 & MATDSCT2.1		
VII	MATDSCT7.2	PO 2, PO 4, PO 5, PO 10	MATDSCT3.1		
VII	MATDSCT7.3	PO 2, PO 4, PO 5, PO 10	MATDSCT3.1		
VIII	MATDSCT8.1	PO 2, PO 4, PO 5, PO 10	MATDSCT5.1		
VIII	MATDSCT8.2	PO 2, PO 4, PO 5, PO 10	MATDSCT4.1		VIVA-VOCE
VIII	MATDSCT8.3	PO 2, PO 4, PO 5, PO 10	MATDSCT7.3		

** 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.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 Practical's on Complex Analysis	25	25
VI	MATDSCMT6.1	Theory	3	Numerical Analysis	60	40
	MATDSCMP6.1	Practical	2	Theory based Practical's 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.Sc.(Honors) with Mathematics as Major in the 3rd Year
(For Model IIA)

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	4Courses 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 Courses4x(3+2) =20	-----	2Courses 2 x 3 =06	---	2Courses 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 1Course 1 x 3 =3 Total=25	-----	2Courses 2 x 3 =6 Res.Meth1 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.Sc. with Mathematics as Major Subject &
B.Sc. (Hons) Mathematics

SEMESTER – I

MATDSCT 1.1: 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

- Learn to solve system of linear equations.
- Solve the system of homogeneous and non homogeneous linear of m equations in n variables by using concept of rank of matrix, finding eigen values and eigenvectors.
- Sketch curves in Cartesian, polar and pedal equations.
- Students will be familiar with the techniques of integration and differentiation of function with real variables.
- Identify and apply the intermediate value theorems and L'Hospital rule.

Unit-I: Matrix: Recapitulation of Symmetric and Skew Symmetric matrices, 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. Eigen values and Eigen vectors of square matrices, Cayley-Hamilton theorem, inverse of matrices by Cayley-Hamilton theorem (Without Proof), real symmetric matrices and their properties, reduction of such matrices to diagonal form.

14 Hours

Unit-II: 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, evolutes and envelops.

14 Hours

Unit-III: Differential Calculus-I: Limits, Continuity, Differentiability and properties. Properties of continuous functions. 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 usingL'Hospitalrule.

14 Hours

Unit-IV: Successive Differentiation: n^{th} Derivatives of Standard functions $e^{ax+b}, (ax+b)^n$, $\log(ax+b), \sin(ax+b), \cos(ax+b)$, $e^{ax}\sin(bx+c), e^{ax}\cos(bx+c)$, Leibnitz theorem and its applications. Tracing of curves (standard curves).

14 Hours

Reference Books:

1. University Algebra - N.S. Gopala Krishnan, New Age International (P)Limited, 2015.
2. Theory of Matrices - B S Vatsa, New Age International Publishers, 2010.
3. Matrices - A R Vasista, Krishna Prakashana Mandir, 2014.
4. Differential Calculus - Shanti Narayan, S. Chand & Company, NewDelhi, 1998.
5. Applications of Calculus, Debasish Sengupta, Books and Allied (P) Ltd.,2019.
6. Calculus – Lipman Bers, Holt, Rinehart &Winston, 1969.
7. Calculus - S Narayanan & T. K. Manicavachogam Pillay, S. Viswanathan Pvt.Ltd., vol. I &II, 2009.
8. Schaum's Outline of Calculus - Frank Ayres and Elliott Mendelson, 5th ed. USA: Mc.Graw, 2008.

MATDSCP 1.1: Practical's on 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 problem on algebra and calculus theory studied in MATDSCT 1.1 by using FOSS software's.
- Acquire knowledge of applications of algebra and calculus through FOSS.

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

Suggested Software's: Maxima/Python.

1. Introduction to Python/Maxima.
2. Basic commands in Python/Maxima.
3. Simple examples using Python/Maxima.
4. Matrices –Algebra of matrices.
5. Computation of rank of matrix.
6. Solving the system of homogeneous and non-homogeneous linear algebraic equations.
7. Computation of inverse of matrix using Cayley-Hamilton theorems.
8. Finding the angle between the radius vector and tangent and angle between two curves.
9. Finding the radius of curvature of the given curve.
10. Verification of mean value theorems.
11. Find the Taylor's and Maclaurin's expansion of the given function.
12. Indeterminate forms and evaluation of limits using L-Hospital Rule.
13. Finding the n^{th} derivative.
14. Tracing of standard curves.

Open Elective Course

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

MATOET 1.1: 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

- Learn to solve system of linear equations.
- Solve the system of homogeneous and non homogeneous m linear equations by using the concept of rank of matrix, finding eigen values and eigenvectors.
- Students will be familiar with the techniques of differentiation of function with real variables.
- Identify and apply the intermediate value theorems and L'Hospital rule.
- Learn to trace some standard curves.

Unit-I: Matrices: Recapitulation of Symmetric and Skew Symmetric matrices, Algebra of Matrices; Row and column reduction, 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. Eigen values and Eigen vectors of square matrices, Cayley-Hamilton theorem, inverse of matrices by Cayley-Hamilton theorem (Without Proof). Real symmetric matrices and their properties, reduction of such matrices to diagonal form.

14 Hours

Unit-II: Differential Calculus: Limits, Continuity, Differentiability and properties. 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 examples.

Unit-III: Successive Differentiation: n^{th} Derivatives of Standard functions $e^{ax+b}, (ax+b)^n$, $\log(ax+b), \sin(ax+b), \cos(ax+b)$, $e^{ax}\sin(bx+c), e^{ax}\cos(bx+c)$, Leibnitz theorem and its applications.

14 Hours

Reference Books:

1. University Algebra - N.S. Gopala Krishnan, New Age International (P)Limited, 2015
2. Theory of Matrices - B S Vatsa, New Age International Publishers, 2010.
3. Matrices - A R Vasista, Krishna Prakashana Mandir, 2014.
4. Differential Calculus - Shanti Narayan, S. Chand & Company, NewDelhi, 1998.
5. Applications of Calculus, Debasish Sengupta, Books and Allied (P) Ltd.,2019.
6. Calculus – Lipman Bers, Holt, Rinehart &Winston, 1969.
7. Calculus - S Narayanan & T. K. Manicavachogam Pillay, S. Viswanathan Pvt. Ltd., vol. I &II, 2009.
8. Schaum's Outline of Calculus - Frank Ayres and Elliott Mendelson, 5th ed. USA: Mc.Graw, 2008.

Open Elective
(For Students of other than Science Stream)

MATOE 1.1(B): Business Mathematics-I	
Teaching Hours : 3 Hours/Week	**Credits: 3**
Totat Teaching Hours: 42 Hours	**Max. Marks: 100** **(S.A.- 60 + I.A. – 40)**

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

- Translate the real word problems through appropriate mathematical modeling.
- Explain the concepts and use equations, formulae and mathematical expression and relationship in a variety of context.
- Finding the extreme values of functions.
- Analyze and demonstrate the mathematical skill require in mathematically intensive areas in economics and business.

Unit-I: Algebra – Set theory and simple applications of Venn Diagram, relations, functions, indices, logarithms, permutations and combinations. Examples on commercial mathematics.

14 Hours

Unit - II: Matrices – Definition of a matrix; types of matrices; algebra of matrices. Properties of determinants; calculations of values of determinants upto 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 - III: Percentage, Ratios and Proportions – Percentages: Definition, Calculation of percentage, Ratios- Types of Ratios, Duplicate, Triplicate and Sub-Duplicate of ratio, Proportions - Definitions and properties- cross product property and Reciprocal property, United proportions – Continued proportions – Compound proportions, Examples on commercial mathematics.

14 Hours

Reference Books:

1. Basic Mathematics, Allen R.G.D, Macmillan, NewDelhi, 1962.
2. Mathematics for Economics, Dowling,E.T., Schaum's Series,McGrawHill,London, 2020.
3. Quantitative Techniques in Management, Vohra, N.D., Tata McGraw Hill, NewDelhi, 2006.
4. Business Mathematics, Soni R.S., Pitamber Publishing House,Delhi, 1996.

SEMESTER – II

MATDSCT 2.1: 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

- Recognize the mathematical objects called Groups.
- Link the fundamental concepts of groups and symmetries of geometrical objects.
- Explain the significance of the notions of Cosets, normal subgroups and factor groups.
- Understand the concept of differentiation and fundamental theorems in differentiation and various rules.
- Find the extreme values of functions of two variables.

Unit-I: Groups-I: Definition of a group with examples and properties, congruence, problems. Subgroups, center of groups, order of an element of a group and its related theorems, cyclic groups, Coset decomposition, Lagrange's theorem and its consequences. Fermat's theorem and Euler's ϕ function.

14 hours

Unit-II: Groups-II: Normal subgroups-Examples and problems, Quotient group, Homomorphism and isomorphism of groups, Kernel and Image of a homomorphism, Normality of the kernel, Fundamental theorem of homomorphism, Properties related to isomorphism, Permutation group, Cayley's theorem.

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.

14 hours

Reference Books:

1. Topics in Algebra, I N Herstein, Wiley Eastern Ltd., NewDelhi, 2006.
2. Higher algebra, Bernard & Child, Arihant, 2016.
3. Modern Algebra, Sharma and Vasista, Krishna Prakashan Mandir, Meerut,U.P,1960.
4. Differential Calculus, Shanti Narayan, S. Chand & Company, NewDelhi, 1998.
5. Integral Calculus, Shanti Narayan and P K Mittal, S. Chand and Co. Pvt.Ltd., 2015.
6. Schaum's Outline Series, Frank Ayres and Elliott Mendelson, 5th ed. USA: Mc. Graw Hill.,2008.
7. Mathematical Analysis, S C Malik, WileyEastern, 1992.
8. A Course in Abstract Algebra, Vijay K Khanna and S K Bhambri, Vikas Publications, 2018.
9. Text Book of B.Sc. Mathematics, G K Ranganath, S Chand &Company, 2011.

PRACTICAL

MATDSCP 2.1: On 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 problem on algebra and calculus by using FOSS software's.
- Acquire knowledge of applications of algebra and calculus through FOSS.

Practical/Lab Work to be performed in Computer Lab

Suggested Software's: Maxima/Python.

1. Program to construct Cayley's table and test abelian for given finite set.
2. Program to find all possible cosets of the given finite group.
3. Program to find generators and corresponding possible subgroups of a cyclic group.
4. Programs to verification of Lagrange's theorem with suitable examples.
5. Program to verify the Euler's ϕ function for a given finite group.
6. Program to verify the given function is Homomorphism and Isomorphism.
7. Program to verify the Euler's theorem and its extension.
8. Program to find Jacobian.
9. Programs to construct series using Maclaurin's expansion for functions of two variables.
10. Program to evaluate the line integrals with constant and variable limits.
11. Program to evaluate the Double integrals with constant and variable limits.
12. 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)

MATOET 2.1(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.
- Link the fundamental concepts of groups and symmetries of geometrical objects.
- Explain the significance of the notions of Cosets, normal subgroups and factor groups.
- Understand the concept of differentiation and fundamental theorems in differentiation and various rules.
- Find the extreme values of functions of two variables.
- To understand the concepts of multiple integrals and their applications.

Unit-I: Groups: Definition of a group with examples and properties, congruence, problems. Subgroups, center of groups, order of an element of a group and its related theorems, cyclic groups, Coset decomposition, Factor groups, Lagrange's theorem and its consequences. Fermat's theorem and Euler's ϕ function.

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 twovariables.

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.

14 hours

Reference Books:

1. Topics in Algebra, I N Herstein, 2nd Edition, Wiley Eastern Ltd., NewDelhi, 2006.
2. Higher algebra, Bernard & Child, Arihant Pub, 2016.
3. Modern Algebra, Sharma and Vasishta, Krishna Prakashan Mandir, Meerut,U.P, 1960.
4. A Course in Abstract Algebra, Vijay K Khanna and S K Bhambri, VikasPublications, 2018.
5. Differential Calculus, Shanti Narayan, S. Chand & Company, NewDelhi, 1998.
6. Integral Calculus, Shanti Narayan and P K Mittal, S. Chand and Co. Pvt.Ltd., 2015.
7. Schaum's Outline Series, Frank Ayres and Elliott Mendelson, 5th ed. USA:McGraw Hill.,2008.
8. Mathematical Analysis, S.C. Malik, WileyEastern, 1992.
9. Text Book of B.Sc. Mathematics, G.K. Ranganath, S.Chand & Company, 2011.

Open Elective
(For Students of other than science stream)

MATOET 2.1(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 concept in international business concept with functioning of global trade.
- Evaluate the legal, social and economic environment of business.
- Apply decision-support tools to business decision making.
- Will be able to apply knowledge of business concepts and functions in an integrated manner.

Unit - I: Mathematical logic: Propositions, Truth values, Logical connectives, Truth table, Tautology and Contradiction, Logical equivalence, Negations, Converse, Inverse and Contrapositive of condition proposition and examples on commercial mathematics.

14 hours

Unit - II: 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 Installments (EMI) by Interest of Reducing Balance and Flat Interest methods, Examples and Problems.

14 Hours

Unit - III: Measures of central Tendency and Dispersion: Frequency distribution: Raw data, attributes and variables, Classification of data, frequency distribution, cumulative frequency distribution, Histogram and give curves. Requisites of ideal measures of central tendency, Arithmetic Mean, Median and Mode for ungrouped and grouped data. Combined mean, Merits and demerits of measures of central tendency, Geometric mean: definition, merits and demerits, Harmonic mean: definition, merits and demerits, Choice of A.M., G.M. and H.M. Concept of dispersion, Measures of dispersion: Range, Variance, Standard deviation (SD) for grouped and ungrouped data, combined SD, Measures of relative dispersion: Coefficient of range, coefficient of variation. Examples and problems.

14 Hours

Reference Books:

1. Practical Business Mathematics, S. A. Bari New Literature Publishing Company New Delhi, 1971.
2. Mathematics for Commerce, K. Selvakumar Notion Press Chennai, 2014.
3. Business Mathematics with Applications, Dinesh Khattar& S. R. Arora S. Chand Publishing New Delhi, 2001.
4. Business Mathematics and Statistics, N.G. Das &Dr. J.K. Das McGraw Hill New Delhi, 2017.
5. Fundamentals of Business Mathematics, M. K. Bhowal, Asian Books Pvt. Ltd New Delhi, 2007.
6. Mathematics for Economics and Finance: Methods and Modeling, Martin Anthony and Norman, Biggs Cambridge University Press Cambridge, 2009.

7. Financial Mathematics and its Applications, Ahmed Nazri Wahidudin Ventus Publishing APS Denmark, 2011.
8. Fundamentals of Mathematical Statistics, Gupta S.C. and Kapoor V.K, Sultan Chand and Sons, New Delhi, 2002.
9. Statistical Methods , Gupta S.P.: Sultan Chand and Sons, New Delhi, 2021.
10. Applied Statistics, Mukhopadhya Parimal New Central Book Agency Pvt. Ltd. Calcutta, 2018.
11. Fundamentals of Statistics, Goon A.M., Gupta M.K. and Dasgupta, B. World Press Calcutta, 2008.
12. Fundamentals of Applied Statistics, , Gupta S.C. and Kapoor V.K, Sultan Chand and Sons, New Delhi, 2014.

BANGALORE UNIVERSITY

Department of Mathematics
Jnanabharathi Campus
Bengaluru – 560 056

Syllabus for
Mathematics
Under-Graduate (UG) Programmme
III & IV Semester

Framed according to the
National Education Policy (NEP 2020)

August 18, 2022

Proceedings of the BOS meeting in UG-Mathematics-Regular, held on 18th August 2022 in the Department of Mathematics, JB Campus, Bangalore University, Bangalore-560 056 at 3.00 pm

The following members attended the meeting to frame the NEP new syllabus 3rd and 4th semester for undergraduate degree program B.A./B.Sc with mathematics as Major Subject, B.A./B.Sc.(Hons) Mathematics & Open electives

1.	Prof. Harina P. Waghmore	Chairperson	
2.	Prof. Jayadeva. M	Member	
3.	Prof. T.R. Marulasiddappa	Member	
4.	Sri. Mahesh H.S	Member	
5.	Smt. Veena M.G	Member	
6.	Smt. Shobha. V	Member	
7.	Dr. Maheshwari P.G	Member	
8.	Dr. S. Sigarakanti	Member	ABSENT
9.	Dr. R. Sumithra	Member	

The Chairperson thanked the members for their cooperation.

[Dr. HARINA P. WAGHAMORE]
CHAIRPERSON

ಗಣಿತಶಾಸ್ತ್ರ ವಿಭಾಗ
ಜ್ಞಾನಭಾರತಿ ಆವರಣ
ಬೆಂಗಳೂರು ವಿಶ್ವವಿದ್ಯಾಲಯ
ಬೆಂಗಳೂರು - 560 056.

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Preamble

The subject wise expert committee to draft model curriculum contents in Mathematics constituted by the Department of Higher Education, Government of Karnataka, Bangalore vide GO No. ED 260 UNE 2019 (PART-1) DATED 13.08.2021 is pleased to submit its partial report on the syllabus for the First Year (First & Second Semesters) B.Sc.(Basic/Honors) Mathematics and detailed Course Structure for B.Sc.(Honors) Mathematics and M.Sc. (One Year) Mathematics.

The committee discussed various models suggested by the Karnataka State Higher Education Council in its joint meetings with the Chairpersons of Board of Studies of all state universities in Karnataka and resolved to adopt Model IIA (Model Program Structure for the Bachelor of Science (Basic/Hons.) for the subjects with practical's with Mathematics as Major/Minor.

To achieve the core objectives of the National Education Policy 2020 it is unanimously resolved to introduce computer based practical's for the Discipline Core (DSC) courses by using Free and Open Source Software's (FOSS) tools for implementation of theory based on DSC courses as it is also suggested by the LOCF committee that the papers may be taught using various Computer Algebra System (CAS) software's such as Mathematica, MATLAB, Maxima and R to strengthen the conceptual understanding and widen up the horizon of students' self-experience. In view of these observations the subject expert committee suggested the software's Python/ Maxima/ Scilab/ Maple/ MatLab/ Mathematica for hands on experience of implementation of mathematical concepts in computer based lab.

The expert committee suggests the implementation this curriculum structure in all the Departments of Mathematics in Universities/Colleges in Karnataka.

The subject expert committee designed the Course Learning Outcome (CO) to help the learners to understand the main objectives of studying the courses by keeping in mind of the Programme outcomes (PO) of the graduate degree with honors in Mathematics or a graduate degree with Mathematics as a major subject.

As the Mathematics subject is a vast with several branches of specializations, it is difficult for every student to learn each branch of Mathematics, even though each paper has its own importance. Hence the subject expert committee suggests number of elective papers (for both Discipline electives and Open

Electives) along with Discipline Core Courses. The BoS in Mathematics of universities may include additional electives based on the expertise of their staff and needs of the students'.

A student can select elective paper as per her/his needs and interest. The subject expert committee in Mathematics suggests that the concerned Department/Autonomous Colleges/Universities to encourage their faculty members to include necessary topics in addition to courses suggested by the expert committee.

B.Sc. Mathematics (Honors)

Programme Outcomes (PO): By the end of the program the students will be able to:

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 this 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 this 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 modeling ability, problem solving skills.
PO 5	**Research related skills:** The completing this programme 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 this programme will enable the learner to use appropriate softwares to solve system of algebraic equation and differential equations.
PO 7	**Self –directed learning**: The student completing this 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 this 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**: This programme provides self-directed learning and lifelong learning skills. This 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
Experiential Learning (Internship etc.)	--	--

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

Model IIA

Semester	Course No.	Theory/ Practical	Credits	Paper Title	Marks	
					S.A.	I.A.
I	MATDSCT1.1	Theory	4	Algebra - I and Calculus - I	60	40
	MATDSCP1.1	Practical	2	Theory based Practicals on 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	Algebra - II and Calculus - II	60	40
	MATDSCP2.1	Practical	2	Theory based Practicals on 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 Real Analysis-I	60	40
	MATDSCP3.1	Practical	2	Theory based Practicals on Ordinary Differential Equations and Real Analysis-I	25	25
	MATOET3.1	Theory	3	(A) Ordinary Differential Equations (B) Quantitative Mathematics	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 Analysis and Complex Analysis	60	40
	MATDSCP5.1	Practical	2	Theory based Practicals on Real Analysis and Complex Analysis	25	25
	MATDSCT5.2	Theory	3	Ring Theory	60	40
	MATDSCP5.2	Practical	2	Theory based Practicals on Ring Theory	25	25
	MATDSET5.1	Theory	3	(A) Vector Calculus (B) Mechanics (C) Mathematical Logic	60	40
VI	MATDSCT6.1	Theory	3	Linear Algebra	60	40
	MATDSCP6.1	Practical	2	Theory based Practicals on Linear Algebra	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	(A) Analytical Geometry in3D (B) Number Theory (C) Special Functions (D) History of Bhârtîya Gaṇita	60	40
Exit Option with Bachelor of Arts, B.A./ Bachelor of Science, B.Sc. Degree						
VII	MATDSCT7.1	Theory	3	Discrete Mathematics	60	40
	MATDSCP7.1	Practical	2	Theory based Practicals on Discrete Mathematics	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 Analysis	60	40
	MATDSET 7.1	Theory	3	(A) Graph Theory (B) Entire and Meromorphic Functions (C) General Topology (D) Bhâratîya Trikoṇmiti Śâstra	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	Advanced Partial Differential Equations	60	40
	MATDSCT8.3	Theory	3	Fuzzy Sets and Fuzzy Systems	60	40
	MATDSET 8.1	Theory	3	(A) Operations Research (B) Lattice theory and Boolean Algebra (C) Mathematical Modeling (D) *Aṅkapâśa* (Combinatorics)	60	40
	MATDSET 8.2	Research Project	6 (3 + 3)	Research Project* OR Any Two of the following electives (A) Finite Element Methods (B) Cryptography (C) Information Theory and Coding (D) Graph Theory and Networking	120 OR 60 60	80 OR 40 40
Award of Bachelor of Science Honours, B.Sc.(Hons) Degree in Mathematics						

One Year M.Sc. degree in Mathematics (Two Semesters)						
Semester	**Course Number**	**Theory/ Practic al**	**Credits**	**Title of the Course**	**S.A.**	**I.A.**
I	PGMATDSCT1.1	Theory	3	C++ Programming for Mathematics	60	40
	PGMATDSCP1.1	Practical	2	Computer Practical's on C++ Programming for Mathematics	25	25
	PGMATDSCT1.2	Theory	3	Computational Numerical Methods	60	40
	PGMATDSCP1.2	Practical	2	Computer Practical's on CNM	25	25
	PGMATDSCT1.3	Theory	4	Functional Analysis	60	40
	PGMATDSET1.1	Theory	3	(A) Fluid Mechanics –I (B) Computational Fluid Mechanics (C) Contact Geometry (D) Fuzzy Topology (E) Ramanujan Theta Function and Continued Fractions	60	40
	PGMATDSET1.2	Theory	3	(A) Advanced Graph Theory (B) Partition Theory (C) Algebraic Number Theory (D) Riemannian Geometry	60	40
II	PGMATDSCT2.1	Theory	4	Measure Theory	60	40
	PGMATDSCT2.2	Theory	4	Differential Geometry	**60**	**40**
	PGMATDSCT2.3	Theory	3	Mathematical Methods	60	40
	PGMATDSET2.1	Theory	3	(A) Fluid Mechanics –II (B) Magneto hydrodynamics (C) Finsler Geometry and Relativity (D) Mathematical Modeling	60	40
	PGMATDSET2.2	Project	6	Research Project	120	80

- In lieu of the research Project, two additional elective papers/Internship may be offered

Abbreviation for MATDSCT1.1 /MATDSCP1.1

MAT – Mathematics ; DSC – Discipline Core; T – Theory/ P – Practical; 1 – First Semester; .1 – Course 1

PGMATDSCT1.1 : PG- Post Graduate ; MAT- Mathematics; DSC- Discipline Core; T- Theory 1 –First Semester; .1 – Course 1

CURRICULUM STRUCTURE FOR UNDERGRADUATE DEGREE PROGRAM

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

Subject : Mathematics

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	-	MOOC	CLASS TESTS
II	MATDSCT2.1	PO 1, PO 2, PO 3, PO 8	MATDSCT1.1	PROBLEM SOLVING	
III	MATDSCT3.1	PO 1, PO 4, PO7, PO 8	-----	SEMINAR	SEMINAR
IV	MATDSCT4.1	PO 1, PO 4, PO7, PO 8	MATDSCT3.1	PROJECT BASED LEARNING	QUIZ
V	MATDSCT5.1	PO 1, PO 2, PO 3, PO 5	----		ASSIGNMENT
V	MATDSCT5.2	PO 3, PO 4, PO 7, PO10	MATDSCT2.1	ASSIGNMENTS	
VI	MATDSCT6.1	PO 6, PO 7, PO 10.	MATDSCT5.2	GROUP DISCUSSION	
VI	MATDSCT6.2	PO 3, PO 4, PO 5, PO 8, PO 9, PO 10.	MATDSCT1.1 & MATDSCT2.1		
VII	MATDSCT7.1	PO 3, PO 4, PO5, PO 7, PO 9.	MATDSCT1.1 & MATDSCT2.1		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	MATDSCT3.1		
VIII	MATDSCT8.1	PO 2, PO 4, PO 5, PO 10	MATDSCT5.1		
VIII	MATDSCT8.2	PO 2, PO 4, PO 5, PO 10	MATDSCT4.1		VIVA-VOCE
VIII	MATDSCT8.3	PO 2, PO 4, PO 5, PO 10	MATDSCT7.3		

** 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.Sc. with Mathematics as a Minor in the 3rd Sem

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 Practical's on Complex Analysis	25	25
VI	MATDSCMT6.1	Theory	3	Numerical Analysis	60	40
	MATDSCMP6.1	Practical	2	Theory based Practical's 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.Sc.(Honors) with Mathematics as Major in the 3rd Sem
(For Model IIA)

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	4Courses 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 Courses4x(3+2) =20	-----	2Courses 2 x 3 =06	---	2Courses 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 1Course 1 x 3 =3 Total=25	-----	2Courses 2 x 3 =6 Res.Meth1 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 – 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 equation to be exact. 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 second and higher order with constant coefficients. Complimentary function, Particular integral when the RHS is of the form e^{ax}, sin(ax+b), cos(ax+b), x^n, e^{ax} V and x V, where V is a function of x. Cauchy – Euler equations. Second order ordinary linear differential equations with variable coefficients-Method of variation of parameters. Total differential equations P dx +Q dy+ R dz =0. Simultaneous equation of the form $\frac{dx}{P} = \frac{dy}{Q} = \frac{dz}{R}$

14 hrs

Real Analysis :

Unit III: Sequences: Sequences of real numbers, supremum and infimum of a sequence, Bounded sequences. Limit of a sequence. convergent, divergent, and oscillatory sequences. Algebra of convergent sequences, nature of standard sequences. Monotonic sequences and its properties. Cauchy's general principle for convergence of a sequence.

14hrs

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

Reference Books:

1. M.D.Raisinghania, Ordinary Differential Equations & Partial Differential Equations, S. Chand & Company, NewDelhi, 2020.
2. J. Sinha Roy and S Padhy: A course of Ordinary and Partial Differential Equation, Kalyani Publishers, NewDelhi, 2014.
3. D. Murray, Introductory Course in Differential Equations, Orient Longman(India), 2017.
4. W. T. Reid, Ordinary Differential Equations, John Wiley, NewDelhi, 2010.
5. M. L. Khanna, Differential Equations, Jai PrakashNath& Co.Meerut, 1997.
6. S. L. Ross, Differential Equations, 3rd Ed., John Wiley and Sons,1984, 1984.
7. R. G. Bartle and D. R. Sherbert, Introduction to Real Analysis, 3rd Ed., John Wiley and Sons (Asia) Pvt. Ltd., Singapore,2015.
8. Gerald G. Bilodeau, Paul R. Thie, G.E. Keough, An Introduction to Analysis, 2nd Ed., Jones & Bartlett,2010.
9. K. A. Ross, Elementary Analysis: The Theory of Calculus (2^{nd}edition), Springer,2013
10. S. K. Berberian, A First Course in Real Analysis, Springer Verlag, New York,1994.
11. T. Apostol, Mathematical Analysis, Narosa PublishingHouse, 1973.
12. M.L Khanna and L.S. Varhiney, Real Analysis by, Jai Prakash Nath & Co.Meerut, 1997.
13. Kreyzig, Advanced Engineering Mathematics, John Wiley, NewDelhi, 2011.

PRACTICALS

MATDSCP 3.1: Practicals 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 handson 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

Practicals/Lab Work to be performed in Lab

Suggested software: Maxima/Python

1. Solution of Exact differential equation.
2. Solution of differential equations that are solvable for x, y, p.
3. Singular solution of Clairaut's equation.
4. Finding the orthogonal trajectories for cartesian and polar curves and plotting.
5. Finding the complimentary function of linear homogeneous differential equations with constant coefficients.
6. Finding the particular integral of linear homogeneous differential equations with constant coefficients.
7. Solution of second order ordinary linear differential equations with variable coefficients by the method of variation of parameters
8. Verification of integrability of total differential equations.
9. Test the convergence of sequences
10. Test the convergence of series using partial sums.
11. Test the convergence of series by using D'Alembert's ratio Test
12. Test the convergence of series by using Raabe's Test
13. Convergence of alternating series using Leibnitz's theorem.
14. Summation of series.

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 linear differential equations.
- To solve exact differential equations.
- To find the solution to higher-order linear differential equations with constant coefficients.

Unit I: Recapitulation of Differential equations of first order and first degree, Linear differential equations, Exact differential equations, Necessary and sufficient condition for the equations to be exact. **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 second and higher order with constant coefficients. Complimentary function, Particular integral when the RHS is of the form e^{ax}, sin(ax+b), cos(ax+b), x^n, e^{ax} V and x V, where V is a function of x. **14hrs**

Reference Books:

1. M.D.Raisinghania, Ordinary Differential Equations & Partial Differential Equations, S. Chand & Company, NewDelhi, 2020.
2. J. Sinha Roy and S Padhy: A Course of Ordinary and Partial Differential Equation Kalyani Publishers, NewDelhi, 2014.
3. D Murray, Introductory Course in Differential Equations, Orient Longman(India), 2017.
4. W T Reid, Ordinary Differential Equations, John Wiley, NewDelhi, 2010.
5. M. L. Khanna, Differential Equations, Jai Prakash Nath & Co.Meerut, 1997.
6. Shepley L. Ross, Differential Equations, 3rd Ed., John Wiley and Sons,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:NumberSystem

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 there on.

14 Hrs

Unit-II:Theory of equations

Linear equations, quadratic equations, simultaneous equations in two variables, simple application problems - Problems on age calculations. 14Hrs

Unit-III:Quantitative Aptitude

Percentage, Average, Average Speed-problems. Time and distance, problems based on trains, problems on-work and time, work and wages, clock and calendar.

14 Hrs

Reference Books:

1. R.S. Aggarwal, *Quantitative Aptitude*, S. Chand and Company Limited, NewDelhi-110 055, 2010.
2. Abhijit Guha, *Quantitative Aptitude*,5th Edition,Mc.Grawhill publications.2014.
3. R V Praveen,*Quantitative Aptitudeand Reasoning*,PHIpublishers, 2016.
4. R S Aggarwal, Objective Arithmetic, S. Chand & CompanyLtd.,2022.
5. Qazi Zameerddin,Vijay K Khanna, S K Bhambri, *Business Mathematics-II Edition,* vikas publication, 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, Chand Publication, 2017.
8. J K Thukrol, Business Mathematics, abci book: 2020 First Edition, 2020.
9. N. G. Das and J. K. Das, Business Mathematics and Statics, Mc Graw Hill Education, 2017

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 solve wave equation and heat equation.
- Understand the concept of Laplace Transforms.
- Able to find the Fourier series and Fourier Transform of given functions.

Partial Differential Equations:

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

Unit II: Homogeneous and non-homogeneous linear partial differential equations with constant coefficients, Partial differential equations of the second order. Classification of second-order partial differential equations, canonical forms. Solutions of the Heat equation and Wave equation (using Fourier series). **14Hrs**

Integral Transforms:

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. Convolution theorem. Inverse Laplace transforms and its properties. Solution of differential equations by using Laplace transforms. **14Hrs**

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

Reference Books:

1. D. A. Murray, Introductory Course in Differential Equations, Orient and Longman, 2017.
2. H. T. H.Piaggio, Elementary Treatise on Differential Equations and their Applications, CBS Publisher & Distributors,Delhi,1985.
3. G. F. Simmons, Differential Equations, Tata McGrawHill, 1991.

4. S. L. Ross, Differential Equations, 3rd Ed., John Wiley and Sons, India,2004.
5. M. D. Raisinghania, Ordinary Differential Equations & Partial Differential Equations, S. Chand & Company, NewDelhi, 2020.
6. K.Sankara Rao, Introduction to Partial Differential Equations: PHI, Third Edition,2015.
7. I. N. Sneddean, Elements of Partial differential equations, McGraw-Hill International Editions,1986.
8. R. Murray and L. Spiegal (Schaum's Series), Laplace Transforms, 1965.
9. Goel and Gupta, Laplace Transform and Fourier Transforms, Pragati Prakashana, 2020.
10. Sudhir Kumar, Integral Transform Methods in Science & Engineering, CBS Engineering Series,2017.
11. Murray R. Spiegal L, Fourier Transforms, Schaum'Series, McGraw-Hill Education, 1965.
12. Earl David Rainville and Philip Edward Bedient–A short course in Differential Equations, Prentice Hall College Div; 6thEdition, 1981.
13. Sathya Prakash, Mathematical Physics, S Chand and Sons, NewDelhi, 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)**

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 transforms
- To find Laplace transform of various functions
- To find inverse Laplace transform of various functions
- To find the Fourier series of periodic functions
- To find the half range Fourier series of some functions

Practicals/Lab Work to be performed in Lab

Suggested software: Maxima/Python

1 Solution of Partial differential equations of type1 andtype2
2 Solution of Partial differential equations of type3 andtype4
3 Solution of partial differential equation using Charpit's method.
4 Finding the complimentary function of second order homogenous partial differential equation with constant coefficients.
5 Finding the particular integral of second order homogenous partial differential equation with constant coefficients.
6 Solutions to Heat equation using Fourier series method
7 Solutions to Wave equation using Fourier series method
8 Finding the Laplace transform of some simple functions.
9 Finding the inverse Laplace transform of some simple functions
10 Verification of Convolution Theorem.
11 To solve ordinary linear differential equation using Laplace transform.
12 To find the Fourier series of some simple functions withperiod2L
13 To find Half range sine series of some simple functions.
14 To find Half range cosine series of some simple functions.

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

- 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 solve wave equation and heat equation.

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

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

14 Hrs

Unit III: Partial differential equations of the second order. Classification of second-order partial differential equations, canonical forms, Solutions of the Heat equation and Wave equation (using Fourier series). **14Hrs**

Reference Books:

1. D.A. Murray, Introductory course in Differential Equations, Orient and Longman, 2017.
2. H.T. H.Piaggio, Elementary Treatise on Differential Equations and their applications, C.B.S Publisher & Distributors, Delhi,1985.
3. G.F.Simmons, Differential Equations, Tata McGraw Hill, 1991.
4. S.L. Ross, Differential Equations, 3rd Ed., John Wiley and Sons, India,2004.
5. M.R. Speigel, Schaum's outline of Laplace Transform, McGraw-Hill Education, 1965.
6. M. D. Raisinghania, Ordinary Differential equations &Partial differential equations, S. Chand & Company, NewDelhi, 2020.
7. K. Sankara Rao, Introduction to Partial Differential Equations: PHI, Third Edition, 2015.
8. I. N. Snedden, 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 to compute profit and loss, discount and Banker's discount.
- Understand the concept of Linear equations and inequalities and their use in 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 in solving a transportation problem, optimality check, special cases in Transportation problem. The Traveling salesman Problem (Routing Problem). **14Hrs**

Reference Books:

1. R S Agarwal, Objective Arithmetic, S. Chand & Company Ltd. 2022.
2. Mizrahi and Sullivan, Mathematics for Business and Social Sciences an Application approach, John Wiley &sons Inc., 1976.
3. Qazi Zameeruddin, Vijay K Khanna, S K Bhambri, Business Mathematics- II Edition, Vikas Publishing House,2009.
4. S. Kalavathy, Operation Research, Fourth edition, Vikas publication house Pvt.Ltd, 2013.
5. Sreenivasa Reddy M, Operations Research 2nd edition, Sanguine Technical publishers, Bangalore, 2015.
6. S. D. Sharma, Operation Research, Kedar Nath Ram Nath, 2014.

BANGALORE UNIVERSITY

DEPARTMENT OF MATHEMATICS

Syllabus

For

V and VI Semester B.Sc-Mathematics

With effect from

Academic Year 2023-2024

PROCEEDINGS OF THE BOS IN MATHEMATICS(UG) MEETING HELD ON 04, SEPTEMBER 2023 IN THE DEPARTMENT OF MATHEMATICS, BANGALORE UNIVERSITY, JNANABHARATHI, BENGALURU-56 AT 12.30 PM

The chairperson welcomed all the members to the BOS meeting. The agenda of the meeting were taken up for discussions. The final resolutions of the meeting are as mentioned below:

1. Board recommended the names of the new teachers to the BOE-Panels for UG(B.Sc)-Mathematics and UG-Professional (B.Tech)-Mathematics exams 2023-24 based on their service.
2. The panels of Examiners were revised, updated with the inclusion of new eligible teachers and both the panels were approved.
3. The BOS had a discussion on the draft syllabus for V and VI semester B.Sc. and approved the same after necessary corrections.
4. Internship in the VI semester from the institutes/industries.

Sl. No.	Members of the BOS present in the meeting		Signature of the members
1.	Dr. H. G. Nagaraja	Chairman	
2.	Mr. H. S. Mahesh	Member	
3.	Dr. Shailaja M	Member	
4.	Mrs. Jyothi D K	Member	
5.	Mrs. Mamatha H K	Member	
6.	Dr. Jagadeesh R	Member	
7.	Mr. T. R. Marulasiddappa	Member	
8.	Dr. Balbheem Saibanna	Member	
9.	Dr. Shobhankumar D M	Member	

The chairman thanked all the members for extending their help and co-operation in this regard.

CHAIRMAN
BOS IN MATHEMATICS(UG)
Professor & Chairman
Department of Mathematics

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

Programme Outcomes (PO)	
	By the end of the program the students will be able to:
PO 1	**Disciplinary Knowledge** Studying related areas such as computer science and other allied subjects as a Bachelor's 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.
PO 2	**Nature of Mathematics:** Understand the concise, precise, and rigorous nature of Mathematics.
PO 3	**Communication Skills**: Communicate various mathematical concepts effectively using examples and their geometrical visualization. The skills and knowledge gained in this program will lead to proficiency in analytical reasoning, which can be used for modeling and solving real-life problems.
PO 4	**Critical Thinking and Analytical Reasoning:** Acquire the ability of critical thinking and logical reasoning and the capability of recognizing and distinguishing the various aspects of real-lifeproblems.
PO 5	**Problem Solving:** Analyze the problems and identify and define appropriate computing requirements for its solutions. This programme enhances students' overall development and equips them withmathematical modeling ability and problem-solving skills.
PO 6	**Research related skills:** Develop the capability of inquiring about appropriate questions relating to the Mathematical concepts in different areas of Mathematics.
PO 7	**Information/digital Literacy**: Use appropriate software's to solve system of algebraic equation and differential equations.

PO 8	**Self–directed learning**: Work independently and make an in-depth study of various notions of Mathematics.
PO 9	**Moral and ethical awareness/reasoning:** 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 10	**Life long learning:** Have self-directed learning and lifelong learning skills. This programme helps learners think independently and develop algorithms and computational skills to solve real-world problems.
PO 11	**Higher Studies:** Peruse advanced studies and research in pure and applied Mathematical sciences.
PO 12	**Employability:** Know how the program helps enhance employability for jobs in banking, insurance, and investment sectors, data analysis, and various other public and private enterprises.

ASSESSMENT

Weightage for the Assessments (in percentage)

Type of Course	Formative Assessment/I.A.	Summative Assessment (S.A.)
Theory	40 Marks C.1 Sessional Tests: 10 Marks C.2 Assignments/Seminars: 20 Marks C.3 Sessional Test: 10 Marks	60 Marks
Practical	25 Marks C.1 Sessional Tests- 20 Marks C.2 Assignment- 5 Marks	25 Marks
Experiential Learning (Internship etc.)	--	--

COURSES OFFERED

Semester	Course No.	Theory/ Practical	Credits	Paper Title	Marks in percentage	
					S.A.	I.A.
V	MATDSCT 5.1	Theory	4	Real Analysis-II and Complex Analysis	60	40
	MATDSCP 5.1	Practical	2	Theory based Practical's on Real Analysis-II and Complex Analysis	25	25
	MATDSCT 5.2	Theory	4	Vector Calculus and Analytical Geometry	60	40
	MATDSCP 5.2	Practical	2	Theory based Practical's on Vector Calculus and Analytical Geometry	25	25
VI	MATDSCT 6.1	Theory	4	Rings, Fields, and Linear Algebra	60	40
	MATDSCP 6.1	Practical	2	Theory based Practical's on Rings, Fields, and Linear Algebra	25	25
	MATDSCT 6.2	Theory	4	Numerical Analysis	60	40
	MATDSCP 6.2	Practical	2	Theory based Practical's on Numerical Analysis	25	25

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 Outcomes:

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

CO1 Understand Riemann integrals their properties and describe various criteria for integrability of functions.

CO2 Have an overview of the gamma and beta functions and their relation to a variety of integrals.

CO3 Comprehend the fundamental concepts of analytic functions, including the Cauchy-Riemannequations and orthogonal systems.

CO4 Analyze the proof of Cauchy's Integral theorem using Green's theorem and understand its implications.

CO5 Analyze elementary transformations such as translation, rotation, magnification and inversion.

REAL ANALYSIS – II

Unit–I: Riemann Integration-I

Definition & examples for partition of an interval, refinement of a partition, and common refinement.

Riemann Darboux Sums: Upper and lower(Darboux) sum-definition, properties & problems.

Riemann Integral: Upper and Lower integrals (definition & problems), Darboux's theorem and Criterion for Integrability, Integrability of sum, difference, product, quotient, and modulus of integrable functions.

Integral as a limit of sum (Riemann sum)-Problems.

Some integrable functions: Integrability of continuous functions, monotonic functions, bounded functions with a finite number of discontinuity. **15 Hours**

Unit –II: Improper Integrals

Improper Integrals: -Improper integrals of the first, second, and third kind with examples. Improper integral as the limit of proper integral.

Beta-Gamma Functions: -Definitions, Properties, and examples, relations between beta and gamma functions, standard theorems, applications of definite integrals, duplication formula, and its applications. **15 Hours**

COMPLEX ANALYSIS

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

Complex numbers- Cartesian and polar form-geometrical representation-Complex-Plane-Euler's formula-$e^{i\theta} = Cos\theta + iSin\theta$. Functions of a Complex variable-limit, Continuity and Differentiability of a Complex function. Analytic function, Cauchy-Riemann equations in Cartesian forms (Cartesian form only)- Harmonic function-standard properties of analytic functions-construction of analytic function when the real or imaginary part is given-Milne Thomson method. **15 Hours**

Unit –IV: Complex Integration and Transformations:

Complex Integration: Definition, Line integral, properties, and problems. Cauchy's Integral theorem-proof using Green's theorem-direct consequences. Cauchy's Integral formula with proof -Cauchy's generalized formula for the derivatives with proof and applications for evaluation of simple line integrals.

Transformations: Linear Transformation-Definitions-Bilinear transformations, Cross-ratio of four points-Cross-ratio preserving property-Preservation of the family of straight lines and circles-Conformal Mappings-Discussion of the transformations. $w = \frac{1}{z}$, $w = sinz$, $w = cosz$, $w = e^z$. **15 Hours**

FORMULATION OF COURSE ARTICULATION MATRIX:

Course Articulation Matrix correlates the individual COs of a course with POs and PSOs. The strength of correlation is indicated as 3 for substantial (high) 2 for correlation, moderate (medium) correlation, and 1 for slight (low) correlation.

COURSE ARTICULATION MATRIX

MATDSCT 5.1 : REAL ANALYSIS-II AND COMPLEX ANALYSIS												
Course Outcomes	**Program Outcomes**											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	2	2	2	-	1	-	1	1	-
CO2	2	1	-	1	2	1	-	1	-	-	-	-
CO3	2	1	1	1	1	1	1	2	-	1	-	-
CO4	2	2	1	1	-	-	-	-	-	-	1	-
CO5	2	2	-	2	2	-	-	-	-	-	1	-

REFERENCE BOOKS:

1. S. C. Malik and Savita Arora, Mathematical Analysis, 6th ed.: New Age International (P) Ltd. 2021.
2. R. R. Goldberg, Methods of Real Analysis, Oxford and IBH Publishing, 2020.
3. R. G. Bartle and D. R. Sherbert, Introduction to Real Analysis, 4ed, Wiley, 2021.
4. Ajit Kumr and S. Kumaresan - A Basic Course in Real Analysis, Taylor and Francis Group, 2014.
5. W. Rudin, Principles of Mathematical Analysis, 3rd Edition, McGraw Hill Education, 2017.
6. L. V. Ahlfors, Complex Analysis, 3rd, McGraw Hill Education, 1978.
7. B. P. Palka, Introduction to the Theory of Function of a Complex Variable, Springer, 2012.
8. S. Lang, Complex Analysis, 4th ed. Springer, 2003.
9. Shanthinarayan and P. K. Mittal, Theory of Functions of a Complex Variable, 2nd ed. S. Chand Publishers, 2005.
10. S. Ponnuswamy, Foundations of Complex Analysis, 2nd ed., Narosa, 2011.
11. J. W. Brown & R. V. Churchill, Complex Variables and Applications, 8th ed, McGraw Hill Companies, 2017.

WEB RESOURCES:

1. https://nptel.ac.in/courses/109104124

MATDSCP 5.1: PRACTICAL'S 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 Outcomes:

This course will enable the students to

CO1 Learn Free and Open-Source Software (FOSS) tools for computer programming

CO2 Solve the problem of Real Analysis, and Complex Analysis studied in **MATDSCT 5.1by** using FOSS software's.

CO3 Acquire knowledge of applications of Real Analysis and Complex Analysis through FOSS.

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

Suggested Programs:

1. Program to check whether a given set of real numbers attains supremum or infimum.
2. Program to find upper and lower Riemann sums with respect to a givenpartition.
3. Program to test Riemann Integrability.
4. Program to evaluate Riemann integral as a limit of sum.
5. Evaluation of the integrals using the Gamma function.
6. Evaluation of the integrals using the Beta function.
7. Program on verification of Cauchy–Riemann equations (Cartesian form)or test for analyticity.
8. Program to check whether a function is harmonic or not.
9. Program to construct analytic functions (through the Milne–Thompson method).
10. Program to find a Cross-ratio of four points.

COURSE ARTICULATION MATRIX

MATDSCP 5.1 : PRACTICALS ON REAL ANALYSIS-II AND COMPLEX ANALYSIS												
Course Outcomes	**Program Outcomes**											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	-	-	2	3	2	3	3	-	3	2	3
CO2	2	-	-	2	3	1	2	1	-	2	2	1
CO3	1	1	1	-	2	3	-	1	-	1	2	1

REFERENCES:

1. Python: The Complete Reference IV Edition 2018, Martin C. Brown, Mc. Graw Hill Publication.
2. https://www.geeksforgeeks.org/python-math-library-gamma-function/

MATDSCT 5.2: VECTOR CALCULUS AND ANALYTICAL GEOMETRY	
Teaching Hours: 4 Hours/Week	**Credits: 4**
Total Teaching Hours: 60 Hours	**Max. Marks: 100 (S.A. 60 + I.A. 40)**

Course Outcomes:

This course will enable the students to

CO1 Get introduced to the fundamentals of vector differential and integral calculus.

CO2 Get familiar with the various differential operators and their properties.

CO3 Get acquainted with the various techniques of vector integration.

CO4 Learn the applications of vector calculus.

CO5 Recollect the fundamentals of Analytical Geometry and interpret the geometrical aspects of planes and lines in 3D.

VECTOR CALCULUS

Unit – I: Vector Algebra

Vector Algebra: Multiple product – scalar triple product, vector triple product, geometrical interpretation, related problems, vector function of a scalar variable – interpretation as a space curve, derivative, tangent, normal, and binormal vectors to a space curve.

Scalar field: Gradient of a scalar field, geometrical meaning, directional derivative, unit normal to the surfaces - tangent plane and normal to the surface.

Vector field: Divergence and curl of a vector field, solenoidal and irrotational fields, Laplacian of a scalar field, Vector identities. **15 Hours**

Unit – II: Vector Integration

Vector Integration – Definition and basic properties, vector line integral, surface integral, and volume integral; **Green's theorem in the plane** – Proof and related problems; **Gauss' Divergence theorem** – Proof and related problems; **Stokes' theorem** – Proof and related problems. **15 Hours**

ANALYTICAL GEOMETRY

Unit-III: **Planes, Straight Lines and Spheres**

Planes: Distance of a point from a plane, Angle between two planes, pair of planes, Bisectors of angles between two planes.

Straight Lines: Equations of straight lines, Distance of a point from a straight line, Distance between two Straight lines, Distance between a straight line and a plane.

Spheres: Different forms, Intersection of two Spheres, Orthogonal intersection. **15 Hours**

Unit-IV: **Curves and Surfaces**

Locus of a point, Algebraic Curves, Conicoid Space Curves, Ruled Surfaces, Classification of quadric surfaces, Cone, Cylinder, Central Conicoid, Tangent plane, Normal, Polar planes, and Polar lines. **15 Hours**

COURSE ARTICULATION MATRIX

MATDSCT 5.2 : VECTOR CALCULUS AND ANALYTICAL GEOMETRY

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	-	1	-	1	-	-	-	1	-	-
CO2	2	1	-	1	1	-	-	1	-	-	1	-
CO3	1	2	1	1	2	1	-	1	-	1	1	1
CO4	1	2	2	2	2	1	1	1	-	2	2	1
CO5	2	2	1	2	1	1	-	1	-	-	-	-

REFERENCE BOOKS:

1. M. D. Raisinghania, Vector Calculus, S. Chand Co.Pvt.Ltd.,2013.
2. M. Spiegel, Vector Analysis, 2nd Edition, Schaum's Outline Series, McGraw Hill Education, 2017.
3. C. E. Weatherburn, Elementary Vector Analysis, Alpha edition, 2019.
4. B. S. Grewal, Higher Engineering Mathematics, 42nd Edition Khanna Publishers, 2017.
5. R. J. T. Bell, An Elementary Treatise on Coordinate Geometry of Three Dimensions, Macmillan India Ltd, 2018.
6. D. Chatterjee, Analytical Geometry: Two and Three Dimensions, Narosa Publishing House, 2009.
7. Shanthi Narayan and P. K. Mittal, Analytical Solid Geometry, 17th ed. S. Chand Company, 2017.

8. A. N. Das, Analytical Geometry of Two and Three Dimensions, 1st ed., New Central Book Agency Pvt. Ltd, 2009.
9. P. N. Wartikar and J. N. Wartikar, A Textbook of Applied Mathematics, Vol. II, Pune Vidyarthi Griha Prakashan, 2008.
10. C. E. Weatherburn, Differential Geometry of Three Dimensions-1, Hassell Street Press, 2021.
11. G. B. Thomas and R.L. Finney, Introduction to Calculus and Analytical Geometry, Narosa Publishing House, 2010.

WEB RESOURCES:

1. https://ocw.mit.edu/courses/res-18-007-calculus-revisited-multivariable-calculus-fall-2011/resources/lecture-6-equations-of-lines-planes/

MATDSCP 5.2: PRACTICAL'S ON ANALYTICAL GEOMETRY AND VECTOR CALCULUS	
Teaching Hours: 4 Hours/Week	**Credits: 2**
Total Teaching Hours: 60 Hours	**Max. Marks: 50 (S.A. 25 +I.A. 25)**

Course Outcomes:

This course will enable the students to

CO1 Learn Free and Open-Source Software (FOSS) tools for computer programming

CO2 Solve problems related to Analytical Geometry and Vector Calculus usingFOSS software.

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

Suggested Programs:

1. Program on multiple products of vectors – Scalar and cross-product.
2. Program on vector differentiation and finding unit tangent.
3. Program to find the gradient and Laplacian of a scalar function.
4. Program to find the divergence and curlof a vector function.
5. Program to evaluate a vector line integral.
6. Program to evaluate a surface integral.
7. Program to evaluate a volume integral.
8. Program to verify Green's theorem.
9. Program to verify Gauss' Divergence theorem
10. Program to verify Stokes' theorem
11. Program to find equation and plot sphere, cone, and cylinder
12. Program to find distance between a straight line and a plane.

COURSE ARTICULATION MATRIX

MATDSCP 5.2 : PRACTICALS ON ANALYTICAL GEOMETRY AND VECTOR CALCULUS												
Course Outcomes	**Program Outcomes**											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	-	2	3	2	3	3	-	-	3	2	3
CO2	1	1	-	3	3	2	2	2	-	2	1	2

REFERENCES:

1. M. C. Brown, Python: The Complete Reference IV Edition 2018, Mc. Graw Hill Publication.

2. https://computationalmindset.com/en/mathematics/integral-calculus-in-python.html

SEMESTER – VI

MATDSCT 6.1: RINGS, FIELDS, AND LINEAR ALGEBRA	
Teaching Hours: 4 Hours/Week	**Credits: 4**
Total Teaching Hours: 60 Hours	**Max. Marks: 100 (S.A. 60 + I.A. 40)**

Course Outcomes:

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

CO1 Understand the concepts of Vector spaces, subspaces, bases dimension, and theirproperties.

CO2 Become familiar with the concepts Eigen eigenvalues and eigenvectors, minimalpolynomials, linear transformations, etc.

CO3 Learn properties of inner product spaces and determine orthogonality in innerproduct spaces.

CO4 Prove various statements in the context of vector spaces.

CO5 Realize the importance of adjoint of a linear transformation and its canonical form.

Unit I: Rings, Integral Domains, Fields

Rings:- Definition and properties of rings, Rings of integers modulo n, Subrings, Ideals-Principal, Prime, and Maximal ideals in commutative ring-examples, and standardproperties following the definition.

Homomorphism and Isomorphism: - properties.

Quotient Rings, Integral Domain, **Fields-** properties following the definition, Fundamental Theorem of Homomorphism of Rings, every field is an integral domain, every finite integral domain is a field with examples. **15 Hours**

Unit – II: Vector spaces

Vector spaces: - Definition, examples, and properties.

Subspaces: - Examples, the criterion for a sub-set to be a subspace, and some properties.

Basis and dimension: 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. Co-ordinates, ordered basis, some basic properties of basis and dimension, and subspace spanned by a given set of vectors. **15 Hours**

Unit – III: Linear Transformations

Linear transformation - Definition, examples, equivalent criteria, some basic properties, and matrix representation and change of basis and effect on associated matrix, similar matrices. Null space, Range space, proof of Rank - Nullity theorem, and related problems. **15 Hours**

Unit – IV: Isomorphism, Eigenvalues and Diagonalization

Homomorphism, Isomorphism, and Automorphism- Examples, order of automorphism and Fundamental theorem of homomorphism**.**

Eigenvalues and Eigenvectors - Computation of Eigenvalues, algebraic multiplicity, some basic properties of eigenvalues, determination of eigenvectors and eigen space, and geometric multiplicity.

Diagonalizability of linear transformation - Meaning, condition based on algebraic and geometric multiplicity (mentioning) and related problems (Only verification of diagonalizability). **15 Hours**

COURSE ARTICULATION MATRIX

MATDSCT 6.1 : RINGS, FIELDS, AND LINEAR ALGEBRA												
Course Outcomes	**Program Outcomes**											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	2	1	2	-	2	-	1	1	1
CO2	2	1	-	2	2	2	1	1	-	1	2	1
CO3	2	2	1	2	2	1	1	1	-	1	1	-
CO4	2	2	2	2	-	1	-	1	-	-	1	-
CO5	2	1	1	1	2	2	-	-	-	-	-	-

REFERENCE BOOKS:

1. I. N. Herstein, Topics in Algebra, 2nd Edition, Wiley, 2006.

2. A. R. Vasishtha, Modern Algebra, 16th Edition, Krishna Prakshan Mandir, 2010.

3. S. H. Friedberg, A. J. Insel and L. E. Spence, Linear Algebra (4th Edition), Prentice-Hall of India Pvt. Ltd, 2003.
4. F. M. Stewart, Introduction to Linear Algebra, Dover Publications, 2019.
5. S. Kumaresan, Linear Algebra, Prentice Hall India Learning Private Ltd., 2000.
6. K. Hoffman and R. Kunze, Linear Algebra, (2nd Edition), Prentice Hall India Leaning Private Ltd. 2015.
7. G. Strang, Linear Algebra and its applications, (2nd Edition), Elsevier, 2015.
8. V. Sahai & V. Bist, Linear Algebra (2nd Edition) Narosa Publishing, 2013.
9. S. Lang, Introduction to Linear Algebra (2nd Edition), Springer India, 2005.

WEB RESOURCES:

1. https://nptel.ac.in/courses/111101115
2. https://ocw.mit.edu/courses/res-18-008-calculus-revisited-complex-variables-differential-equations-and-linear-algebra-fall-2011/resources/ lecture-1-vector-spaces/

MATDSCP 6.1: PRACTICAL'S ON RINGS, FIELDS, AND LINEAR ALGEBRA	
Practical Hours: 4 Hours/Week	**Credits: 2**
Total Practical Hours: 60 Hours	**Max. Marks: 50 (S.A. 25 + I.A. 25)**

Course Outcomes:

This course will enable the students to

CO1 Learn Free and Open-Source Software (FOSS) tools for computer programming.

CO2 Solve the problem on Linear Algebra studied in **MATDSCT 6.1 by** using FOSS software's.

CO3 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 on Commutative ring and ring with unity.
2. Program on integral domain and field.
3. Program on Homomorphism of rings.
4. Program on linear combination of vectors.
5. Program to verify linear dependence and independence.
6. Program to find basis and dimension of the subspaces.
7. Program to verify if a function is a linear transformation or not.
8. Program to find the matrix of linear transformation.
9. Program to find the Eigenvalues and Eigenvectors of a given linear transformation.
10. Program on Rank – nullity theorem.

COURSE ARTICULATION MATRIX

MATDSCP 6.1 : PRACTICALS ON RINGS, FIELDS AND LINEAR ALGEBRA												
Course Outcomes	**Program Outcomes**											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	-	-	2	3	2	3	3	-	3	2	3
CO2	1	1	-	2	3	2	3	2	-	2	2	2
CO3	1	1	1	-	2	2	-	2	-	1	2	2

REFERENCES:

1. M. C. Brown, Python: The Complete Reference IV Edition 2018, , Mc. Graw Hill Publication.
2. M. Tsukada, Y. Kobayashi, H. Kaneko, Sin-Ei Takahasi, K. Shirayanagi, M. Noguchi, Linear Algebra with Python: Theory and Applications, Springer Undergraduate Texts in Mathematics and Technology, Springer Nature Singapore, 2023
3. https://github.com/showell/abstract-algebra

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 Outcomes:

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

CO1 Describe various operators arising in numerical analysis, such as difference operators, shift operators, and so on.

CO2 Articulate the rationale behind various techniques of numerical analysis, such as finding roots, integrals, and derivatives.

CO3 Reproduce the existing algorithms for various tasks as mentioned previously in numerical analysis.

CO4 Apply the rules of calculus and other areas of mathematics in justifying the techniques of numerical analysis and to solve problems using suitable numerical technique.

CO5 Appreciate the profound applicability of techniques of numerical analysis in solving real-life problems and appreciate the way the techniques are modified to improve the accuracy.

Unit – I: Algebraic and Transcendental Equations

Errors:-Significant digits, absolute, relative, percentage errors, rounding off and truncation errors (meanings and related problems), general error formula (derivation of formula and problems based on it), error in series approximation, Taylor series approximations (problems only).

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

15 Hours

Unit – II: System of Linear Algebraic Equations

Direct Methods- Gauss elimination method, Gauss-Jordan elimination method, and LU-Decomposition method.

Iterative Methods: Jacobi method, Gauss-Seidal method, Successive-Over Relaxation (SOR) method**.** **15 Hours**

Unit – III: Polynomial Interpolations

Finite Differences: -Forward, backward, 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 formula, Newton's divided differences, and Newton's general interpolation formula (Discussion on setting up the polynomials, differences between them, and problems on their applications).

15 Hours

Unit-IV: Numerical Differentiation and Integration

Numerical Differentiation: - 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 1/3rd rule, Simpson's 3/8th rule, Weddle's rule and problems. (Derivations for only general quadrature formula, trapezoidal rule, and Simpson's 1/3rd rule and problems on all the formulas). **15 Hours**

COURSE ARTICULATION MATRIX

MATDSCT 6.2 : NUMERICAL ANALYSIS												
Course Outcomes	**Program Outcomes**											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	-	1	2	-	-	-	-	-	1	-
CO2	2	2	1	2	2	1	-	1	-	1	2	2
CO3	-	-	-	1	2	1	1	2	-	-	1	1
CO4	1	2	2	3	1	2	1	2	-	3	2	2
CO5	1	2	1	2	2	2	-	1	-	1	1	2

REFERENCE BOOKS:

1. E. Isaacson and H. B. Keller, Analysis of Numerical methods, revised ed. Dover Publications, 2012.
2. S. S. Sastry, Introductory methods of Numerical Analysis, 5th Edition, PHI Learning Private Limited, 2012.
3. E. Kreyszig, Advanced Engineering Mathematics, 10th ed. Wiley India Pvt. Limited, 2015.
4. B. S. Grewal, Numerical Methods for Scientists and Engineers with Programs in C, C++ & MATLAB,11th ed. Khanna Publishers, 2013.
5. M. K. Jain, S.R.K. Iyengar and R.K.Jain, Numerical Methods for Scientific and Engineering computation,4th Edition, New Age International, 2005.
6. S. R. K. Iyengar, and R. K.Jain, Numerical Methods: Problems and Solutions, 3rd Edition, New Age International, 2020.
7. H.C. Saxena, Finite Difference and Numerical Analysis, S. Chand Publishers, 2010.
8. B. D. Gupta, Numerical Analysis, Konark Publishers Pvt. Ltd, 1990.

MATDSCP 6.2: PRACTICAL'S 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 Outcomes:

This course will enable the students to

CO1 Learn Free and Open-Source Software(FOSS)tools for computer programming

CO2 Solve problems on numerical Analysis studied in **MATDSCT6.2 by** using FOSS software's.

CO3 Acquire knowledge of applications of Numerical Analysis through FOSS.

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

Suggested Software's: Maxima/Scilab/Python/R.

Suggested Programs:

1. Program to find root of an equation using bisection and Regula-Falsi methods.
2. Program to find root of an equation using Newton-Raphson and Secant methods.
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 solve the system of algebraic equations using SOR method.
8. Program to evaluate integral using Trapezoidal rules.
9. Program to evaluate integral using Weddle rules.
10. Program to evaluate integral using Simpson's 1/3rd rule.
11. Program to evaluate integral using Simpson's 3/8th rule.
12. Program to find differentiation at specified point using Newton-Gregory interpolation method.

COURSE ARTICULATION MATRIX

MATDSCP 6.2 : PRACTICALS ON NUMERICAL ANALYSIS												
Course Outcomes	**Program Outcomes**											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	-	-	2	3	2	3	3	-	3	2	3
CO2	-	-	-	2	3	2	3	2	-	2	2	2
CO3	1	1	-	1	2	2	-	2	-	1	2	2

REFERENCES:

1. M. C. Brown, Python: The Complete Reference IV Edition Mc. Graw Hill Publication, 2018.
2. Python Programming and Numerical Methods - A Guide for Engineers and Scientists, Alexandre Bayen, Qingkai Kong, and Timmy Siauw, Academic Press, 2021.
3. https://nptel.ac.in/courses/115104095
4. https://pythonnumericalmethods.berkeley.edu/notebooks/Index.html