॥ सा विद्या या विमुक्तये ॥

स्वामी रामानंद तीर्थ मराठवाडा विद्यापीठ, नांदेड

'ज्ञानतीर्थ', विष्णुपुरी, नांदेड – ४३१ ६०६ (महाराष्ट्र राज्य) भारत

SWAMI RAMANAND TEERTH MARATHWADA UNIVERSITY, NANDED

'Dnyanteerth', Vishnupuri, Nanded - 431 606 (Maharashtra State) INDIA

स्वामी रामानंद तीर्थ मराठवाडा विद्यापीठ, नांदेड

Established on 17th September, 1994, Recognized By the UGC U/s 2(f) and 12(B), NAAC Re-accredited with 'B++' grade

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विज्ञान व तंत्रज्ञान विद्याशाखे अंतर्गत राष्ट्रीय शैक्षणिक धोरण २०२० नुसार पदव्यूत्तर द्वितीय वर्षाचे अभ्यासक्रम (Syllabus) शैक्षणिक वर्ष २०२४–२५ पासून लागू करण्याबाबत.

प रि प त्र क

या परिपत्रकान्वये सर्व संबंधितांना कळविण्यात येते की, या विद्यापीठा अंतर्गत येणा–या सर्व संलग्नित महाविद्यालयामध्ये शैक्षणिक वर्ष २०२४–२५ पासून राष्ट्रीय शैक्षणिक धोरणानुसार पदव्यूत्तर द्वितीय वर्षाचे अभ्यासक्रम लागू करण्याच्या दृष्टीकोनातून विज्ञान व तंत्रज्ञान विद्याशाखे अंतर्गत येणा–या अभ्यासमंडळांनी तयार केलेल्या पदव्यूत्तर द्वितीय वर्षाच्या अभ्यासक्रमांना मा. विद्यापरिषदेने दिनांक १५ मे २०२४ रोजी संपन्न झालेल्या बैठकीतील विषय क्रमांक १५/५९–२०२४ च्या ठरावाअन्वये मान्यता प्रदान केली आहे. त्यानुसार विज्ञान व तंत्रज्ञान विद्याशाखेतील खालील एम. एस्सी द्वितीय वर्षाचे अभ्यासक्रम (Syllabus) लागू करण्यात येत आहेत.

1) M. Sc. II year Biotechnology (Affiliated College)
2) M. Sc. II year Biotechnology (Campus)
3) M. Sc. II year Bioinformatics (Sub Campus Latur)
4) M. Sc. II year Bioinformatics (Affiliated College)
5) M. Sc. II year Clinical Research (Affiliated College)
6) M. Sc. II year Botany (Campus)
7) M. Sc. II year Herbal Medicine
8) M. Sc. II year Boany (Affiliated College)
9) M. Sc. II year Geology (Campus)
10) M. Sc. II year Dairy Science
11) M. Sc. II year Electronics
12) M. Sc. II year Environmental Science
13) M. Sc. II year Environmental Science (Campus)
14) M. Sc. II year Geography (Campus)
15) M. Sc. II year Applied Mathematics
16) M. Sc. II year Mathematics
17) M. Sc. II year Mathematics (Campus)
18) M. Sc. II year Microbiology
19) M. Sc. II year Microbiology (Campus)
20) M. Sc. II year Statistics
21) M. Sc. II year Statistics (Campus)

सदरील परिपत्रक व अभ्यासक्रम प्रस्तुत विद्यापीठाच्या **www.srtmun.ac.in** या संकेतस्थळावर उपलब्ध आहेत. तरी सदरील बाब ही सर्व संबंधितांच्या निदर्शनास आणून द्यावी, ही विनंती.

'ज्ञानतीर्थ' परिसर,
विष्णुपुरी, नांदेड – ४३१ ६०६.
जा.क्र.:शै–१/एनइपी/विवत्रंविपदवी/२०२४–२५/१०९
दिनांक १२.०६.२०२४

डॉ. सरिता लोसरवार
सहा.कुलसचिव
शैक्षणिक (१–अभ्यासमंडळ) विभाग

प्रत : १) मा. आधिष्ठाता, विज्ञान व तंत्रज्ञान विद्याशाखा, प्रस्तुत विद्यापीठ.
२) मा. संचालक, परीक्षा व मुंल्यमापन मंडळ, प्रस्तुत विद्यापीठ.
३) मा. प्राचार्य, सर्व संबधित संलग्नित महाविद्यालये, प्रस्तुत विद्यापीठ.
४) मा. संचालक, सर्व संकुले परिसर व उपपरिसर, प्रस्तुत विद्यापीठ
५) सिस्टीम एक्सपर्ट, शैक्षणिक विभाग, प्रस्तुत विद्यापीठ. याना देवून कळविण्यात येते की, सदर परिपत्रक संकेतस्थळावर प्रसिध्द करण्यात यावे.

SWAMI RAMANAND TEERTH

MARATHWADA UNIVERSITY, NANDED - 431 606

M.A./M.Sc.-II

Subject: Mathematics [MAT]

For Affiliated Colleges

Under the Faculty of
Science and Technology

Effective from Academic year 2024 – 2025
(As per NEP-2020)

Swami Ramanand Teerth Marathwada University, Nanded.
M.A. /M. Sc. (Second Year) (Mathematics)

From Desk of Chairman, Board of Studies of the Subject Mathematics

Preamble:

Taking into consideration the rapid changes in science and technology and new approaches in different areas of Mathematics and related subjects, Board of studies in Mathematics after a thorough discussion with the teachers of Mathematics from Swami Ramanand Marathwada University Nanded and experts from industry as well as other Academic institutions has prepared the syllabus of M.A./M.Sc. II (w.e.f. 2024-25) Mathematics course under the NEP2020.

Program Educational Objectives (PEOs):

PEO1: To equip students with knowledge, abilities and insight in mathematics and related fields.

PEO2: Have the ability to pursue interdepartmental research in Universities in India and abroad.

PEO3: To develop the ability to utilize the mathematical problem-solving methods such as analysis, modeling, programming and mathematical software applications in addressing the practical and heuristic issues.

PEO4: To enable them to work as a mathematical professional or qualify for training as scientific researcher.

PEO5: To enable students to recognize the need for society and the ability to engage in life-long learning.

PROGRAMME OUTCOMES (POs):

After the completion of the program, students will able to:

PO1: Identify, formulate, and analyze the complex problems using the principles of Mathematics.

PO2: Solve critical problems by applying the Mathematical tools.

PO3: Apply the Mathematical concepts, in all the fields of learning including higher research, and recognize the need and prepare for lifelong learning.

PO4: Able to crack competitive examinations, lectureship and fellowship exams approved by UGC like CSIR-NET and SET.

PO5: Apply ethical principles and commit to professional ethics, responsibilities, and norms in the society.

PO6: Gain the knowledge of software which will be useful in Industry.

PO7: To maintain updated curriculum**.**

PROGRAM SPECIFIC OUTCOMES (PSOs):

PSO1: To understand the basic concepts of advanced mathematics.

PSO2: To develop the problems solving skills and computational skills.

PSO3: To enhance self-learning and improve own performance.

PSO4: To formulate mathematical models.

Lt. Dr. Mahesh Sahebrao Wavare
Chairman, Board of Studies of the Mathematics
S.R.T. M. U. Nanded

Members of the Board of Studies in the subject of Mathematics under the faculty of Science and Technology

Sr No	Name of the Member	Designation	Address	Contact Number and Email ID
1	Prof. Dr. Mahesh Sahebrao Wavare	BoS Chairman (Ad hoc)under Section26(18) and BoS Member under section *40(2)(c)*	Rajarshi Shahu Mahavidyalaya (Autonomous), Latur, Tq. & Dist. Latur.	9890620620 maheshwavare@gmail.com
2	Prof. Dr. Dnyaneshwar Dadaji Pawar	*VC Nominated BoS Member Under Section 40(2)(a)*	Director School of Mathematical Sciences, SRTM University, Nanded	*9423124662* *dypawar@yahoo.com*
3	Dr. B. Surendranath Reddy,	*VC Nominated BoS Member Under Section 40(2)(b)(i)*	School of Mathematical Sciences, SRTM University, Nanded	9096077789 surendra.phd@gmail.com bsreddy@srtmun.ac.in
4	Dr. Arun Babarao Jadhav,	*VC Nominated BoS Member Under Section 40(2)(b)(ii)*	DSM's College of Arts, Commerce and Science, Parbhani.	7875118707 arunbjadhav@gmail.com
5	Dr. S. S. Handibag,	*BoS Member Under Section 40(2)(b)(ii)*	Mahatma Basweshwar Mahavidylaya, Latur	9011491162 960417748 sujitmaths@gmail.com
6	Prof. Dr. Vandeo Chimnaji Borkar,	*BoS Member Under Section 40(2)(b)(iii)*	Yeshwant Mahavidyalaya, Nanded	9421769217 borkarvc@gmail.com
7	Dr. Kishor Ramrao Gaikwad,	*BoS Member Under Section 40(2)(b)(iii)*	Science College, Nanded	9923295556 drkr.gaikwad@yahoo.in
8	Dr. Hemant Kishor Undegaonkar,	*BoS Member Under Section 40(2)(b)(iii)*	Bahairji Smarak College, Basmat, Dist. Hingoli	9822546874 hkundegaonkar@gmail.com
9	Dr. S. S. Bellale	*BoS Member Under Section 40(2)(c)*	Dayanand Science College, Latur, Tq. & Dist. Latur – 413512	9405417417 sidhesh.bellale@gmail.com
10	Dr. Ram Govindrao Metkar	*BoS Member Under Section 40(2)(c)*	Indira Gandhi Sr. College, Cidco, New Nanded, Tq. & Dist. Nanded.:	9822312176 rammetkarmath@gmail.com

Swami Ramanand Teerth Marathwada University, Nanded

Faculty of Science & Technology

Credit Framework for PG Program (MA/M.Sc. Mathematics) Second Year

Subject: Mathematics (MAT)

Year & Level 1	Sem	Major Subject		RM 5	OJT / FP 6	Research Project 7	Practicals 8	Credits 9	Total Credits 10
		(DSC) 3	(DSE) 4						
2 And 6	3	**SMATC501 (4 Cr)** Field Theory **SMATC502 (4 Cr)** Functional Analysis **SMATC503 (4 Cr)** Analytical Number Theory	**SMATE501 (4 Cr) (Choose any one)** A. Integral Transforms B. Fluid Mechanics-I C. Fractional Calculus and its Applications-I D. Fuzzy Sets and their Applications-I E. Coding Theory F. NPTEL/SWAYM MOOCs Equivalent Course ***(From same Department)***	--		Research Project **SMATR551 (4Cr)**	**SMATP501 (2 Cr)** Python Programming	**22**	**44**
	4	**SMATC551 (4 Cr)** Numerical Analysis **SMATC552 (4 Cr)** Classical Mechanics	**SMATE551 (4 Cr) (Choose any one)** A. Integral Equations B. Fluid Mechanics-II C. Fractional Calculus and its Applications-II D. Fuzzy Sets and their Applications-II E. Cryptography F. NPTEL/SWAYM MOOCs Equivalent Course ***(From same Department)***	**SVECP 551** Publication Ethics (2 Cr)		Research Project **SMATR552 (6 Cr)**	**SMATP551 (2Cr)** MATLAB Programming	**22**	

M.A/M. Sc. Second Year Semester III *(Level 6.0)*

Teaching Scheme

	Course Code	Course Name	Credits Assigned			Teaching Scheme (Hrs/ week)	
			Theory	Practical	Total	Theory	Practical
Major	**SMATC501**	Field Theory	04	--	**04**	04	--
	SMATC502	Functional Analysis	04	--	**04**	04	--
	SMATC503	Analytical Number Theory	04	--	**04**	04	--
Practical	**SMATP501**	Python Programming	--	02	**02**	--	04
Elective (DSE)	**SMATE501**	(Choose any one) A. Integral Transforms B. Fluid Mechanics-I C. Fractional Calculus and its Applications-I D. Fuzzy Sets and their Applications-I E. Coding Theory F. NPTEL/SWAYM MOOCs equivalent Course	04	--	**04**	04	--
Research Project	**SMATR501**	Research Project	--	04	**04**		04
Total Credits			**16**	**06**	**22**	**16**	**08**

M.A/M. Sc. Second Year Semester III *(Level 6.0)*

Examination Scheme

[20% Continuous Assessment (***CA***) and 80% End Semester Assessment (***ESA***)]

(For illustration we have considered a paper of 02 credits, 50 marks, need to be modified depending on credits of individual paper)

Subject (1)	Course Code (2)	Course Name (3)	Theory				Practical /Project		Total Col (6+7) / Col (8+9) (10)
			Continuous Assessment (CA)			ESA			
			Test I (4)	Test II (5)	Avg of (T1+T2)/2 (6)	Total (7)	CA (8)	ESA (9)	
Major	**SMATC501**	Field Theory	20	20	20	80	--	--	100
	SMATC502	Functional Analysis	20	20	20	80	--	--	100
	SMATC503	Analytical Number Theory	20	20	20	80	--	--	100
Practical	**SMATP501**	Python Programming	--	--	--	--	10	40	50
Elective (DSE)	**SMATE501**	(Choose any one) A. Integral Transforms B. Fluid Mechanics-I C. Fractional Calculus and its Applications-I D. Fuzzy Sets and their Applications-I E. Coding Theory F. NPTEL/SWAYM MOOCs equivalent Course	20	20	20	80	--	--	100
Research Project	**SMATR501**	Research Project					20	80	100

M.A/M. Sc. Second Year Semester IV*(Level 6.0)*

Teaching Scheme

	Course Code	Course Name	Credits Assigned			Teaching Scheme (Hrs/ week)	
			Theory	Practical	Total	Theory	Practical
Major	**SMATC551**	Numerical Analysis	04	--	**04**	04	--
	SMATC552	Classical Mechanics	04	--	**04**	04	--
RM	**SVECP551**	Publication Ethics	02	--	**02**	02	--
Practical	**SMATP551**	MATLAB Programming	--	02	**02**	--	04
Elective (DSE)	**SMATE551**	**(Choose any one)** A. Integral Equations B. Fluid Mechanics-II C. Fractional Calculus and its Applications-II D. Fuzzy Sets and their Applications-II E. Cryptography F. NPTEL/SWAYM MOOCs Equivalent Course ***(From same Department)***	04	--	**04**	04	--
Research Project	**SMATR551**	Research Project	--	06	**06**	--	12
Total Credits			**14**	**08**	**22**	**14**	**16**

M.A/M. Sc. Second Year Semester IV *(Level 6.0)*

Examination Scheme

[20% Continuous Assessment (***CA***) and 80% End Semester Assessment (***ESA***)]

(For illustration we have considered a paper of 02 credits, 50 marks, need to be modified depending on credits of individual paper)

Subject (1)	Course Code (2)	Course Name (3)	Theory				Practical		Total Col (6+7) / Col (8+9) (10)
			Continuous Assessment (CA)			ESA			
			Test I (4)	Test II (5)	Avg of (T1+T2)/2 (6)	Total (7)	CA (8)	ESA (9)	
Major	SMATC551	Numerical Analysis	20	20	20	80	--	--	100
	SMATC552	Classical Mechanics	20	20	20	80	--	--	100
RM	SVECP551	Publication Ethics	10	10	10	40	--	--	50
Practical	SMATP551	MATLAB Programming	--	--	--	--	10	40	50
Elective (DSE)	SMATE551	**(Choose any one)** A. Integral Equations B. Fluid Mechanics-II C. Fractional Calculus and its Applications-II D. Fuzzy Sets and their Applications-II E. Cryptography F. NPTEL/SWAYM MOOCs Equivalent Course A. (***From same Department)***	20	20	20	80	--	--	100
Research Project	SMATR551	Research Project	--	--	--	--	30	120	150

M.A/M. Sc. Second Year Semester-III *(Level 6.0)*

DSC -7

SMATC501: Field Theory (4Cr)

Course objectives: This course is aimed to introduce the theories, concepts and to develop working knowledge on field and to develop a background for studying Commutative algebra and Representation Theory. To introduce the concepts and to develop working knowledge of field extensions, Galois groups and interrelation between group theory and field theory.

Course outcomes:

After completing this course, the student will be able to:

CO1: Understand the algebraic structure of the fields.

CO:2 Analyze properties of Finite, Algebraic, Normal, Simple, Cyclic & Separable extension and Splitting Fields.

CO:3 Compute Galois groups in simple cases and to apply the group-theoretic information to comprehend results about fields and field extensions.

CO4: Study applications of Galois Fields .

Curriculum Details:

oduleNo.	Unit No.	Topic	Hrs. Required to cover the contents
1. 0		**Algebraic Extensions of Fields**	**15**
	1.1	Irreducible polynomial and Eisenstein criterion	
	1.2	Adjunction of roots	
	1.3	Algebraic extensions	
	1.4	Algebraically closed field	
2.0		**Normal and Separable Extension**	**15**
	2.1	Splitting field, Normal extension	
	2.2	Multiple roots, Finite field	
	2.3	Separable extensions	
3.0		**Galois Theory**	**15**
	3.1	Automorphism groups and fixed fields	
	3.2	Fundamental theorem of Galois theory	
	3.3	Fundamental theorem of algebra.	
4.0		**Applications Galois Theory to Classical Problems**	**15**
	4.1	Roots of unity and Cyclotomic polynomials	
	4.2	Cyclic extension	
	4.3	Polynomials solvable by radicals, Symmetric functions	
	4.4	Ruler and Compass construction	
		Total	**60**

Text Book:

P. B. Bhattacharya, S. K. Jain and S. R. Nagpaul, "Basic Abstract Algebra (Second Ed.), Cambridge Univ. Press (Indian Ed.1995).

Module I: Chapter 15 (Art. 1, 2, 3, 4)

Module-II: Chapter 16 (Art. 1, 2, 3, 4, 5)

Module-III: Chapter 17 (Art. 1, 2, 3)

Module-IV: Chapter 18 (Art. 1, 2, 3, 4, 5)

Reference Books:

1. Joseph A. Gallian, Contemporary Abstract Algebra (Fourth Ed.), Narosa, 1999.
2. I. S. Luthar and I. B. S. Passi, "Algebra-Vol. II: Groups", Narosa, New Delhi, 1996.
3. V. K. Khanna, S.K. Bhambri, "A Course in Abstract Algebra", VikasPublicing House.(Second Edition).

M.A/M. Sc. Second Year Semester-III *(Level 6.0)*

DSC-8

SMATC502: Functional Analysis (4Cr)

Course objectives: This course introduce the concepts and develop working knowledge on Banach
Space, Norm of continuous Linear Transformations, continuous Linear functional, Conjugate space, Banach Algebra, Inner Product Space, Hilbert Space, Orthogonal vectors, Orthonormal vectors and sets, conjugate space H*, self-adjoint, normal and unitary operators, Projections, eigen value and eigen vectors, eigen space and Spectrum of T.

Course outcomes:

After completing this course, the student will be able to:

CO1: Identify Normed Linear Space, Banach Space, continous Linear transformations, Conjugate space, Banach Algebra, Graph of L.T.,Hahn-Banach Theorem and it's applications, Open Mapping and Closed Graph Theorems.

CO 2: Analyze Hilbert space, Orthogonal and Orthonormal vectors and sets, Orthogonal Compliments and conjugate space H*., Schwart Lemma, Bessel's Inequality and Riesz representation theorem.

CO3: To Identify, Self Adjoint, Normal, Unitary and Positive operators and to analyze the invariant subspace and reducible transformations.

CO4: To Provide information on Eigen Value, Eigen Vectors, Eigen Spaces and Spectrum of T.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1. 0		**Banach Space**	**15**
	1.1	Normed linear Space, Banach Space, Some examples, Subspace and Quotient Space Holder's Inequality,	
	1.2	Continuous linear transformations, The Hahn-Banach theorem, Applications of Hahn Banach Theorem,	
	1.3	The natural embedding of N in N**, The Open Mapping Theorem, Closed Graph Theorem	
	1.4	The conjugate of an operator, Uniform Boundedness Principle Theorem.	
2.0		**Hilbert Space**	**15**
	2.1	Inner product. Inner product space, Hilbert space, The definition and some simple properties, Parallelogram law, Polarization identity, Schwarz Inequality,	
	2.2	Orthogonal vectors, Orthogonal set, Vector orthogonal to	

		a set, Pythagoras theorem and applications,Orthogonal complements, Pythagoras theorem and applications,	
	2.3	Orthonormal vectors, Orthonormal set Complete orthonormal set, Bessel's Inequality, The conjugate space H*, Riesz Representation Theorem.	
3.0		**Operator and Adjoint of an Operator**	**15**
	3.1	Operatior, The adjoint of on operator, definition and examples. Properties of adjoint of operator of T, The Self adjoint operators,	
	3.2	Positive operators, Normal operators, Real and Imaginary part of an operator. Normal Operator,	
	3.3	Unitary operator, Projections on Hilbert space, Orthogonal Projection. Invariant subspace, Reducibility.	
4.0		**Finite dimensional Spectral Theory**	**15**
	4.1	Introduction, Finite dimensional Hilbert space.	
	4.2	Eigen value, eigen vector	
	4.3	Eigen space, spectrum of an operator,	
	4.4	The spectral theorem.	
		Total	**60**

Text Book:

G. F. Simmons, Introduction to "Topology and Modern Analysis" McGraw-Hill Book Company, International student Edition, New York.

Scope: Module I - Chapter 9.

Module II - Chapter 10 - Art 52 to 55.

Module III - Chapter 10 - Art 56 to 59.

Module IV - Chapter 11 - Art 62.

Reference Books:

1. **B. V. Limaye,** "Functional Analysis", Wiley Eastern Ltd.
2. **G. Bachman and L. Narici** "Functional Analysis" Academic Press 1966.
3. **D. Somasundaram ,** "A First Course in Functional Analysis" Narosa Publication.

M.A/M. Sc. Second Year Semester-III *(Level 6.0)*

DSC -9

SMATC503: Analytical Number Theory

Course objectives: This course introduce the concepts of congruence's and their properties, Chinese Remainder theorem, Fermat's and Wilson's theorem, Primitive roots and indices, Euler's criterion, The Legendre symbol and its properties, Gauss Lemma, Quadratic reciprocity law, Pythagorean triple, arithmetical functions and dirichlet multiplication

Course outcomes:

After completing this course, the student will be able to.

CO1: Understand the concepts of congruence and their properties, solve systems of linear congruence's with different moduli using the Chinese Remainder Theorem

CO2: Analyze primitive roots and indices.

CO3: Discuss Legendre symbol and its properties, Quadratic reciprocity law.

CO4: Study arithmetical functions and Dirichlet multiplication.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1. 0		**The Theory of Congruences**	**15**
	1.1	Congruence's, Basic properties of congruence's,	
	1.2	Binary and decimal representation of integers,	
	1.3	Linear congruence's and Chinese Remainder theorem, Pierre de Fermat theorem,	
	1.4	Fermat's little theorem and pseudo-primes, Wilson's theorem.	
2.0		**Primitive Roots**	**15**
	2.1	The order of an integer modulo n,	
	2.2	Primitive roots for primes, Lagrange's theorem,	
	2.3	Composite numbers having primitive roots, the theory of indices.	
3.0		**The quadratic Reciprocity Law a**	**15**
	3.1	Euler's criterion, The Legendre symbol and its properties	
	3.2	Gauss Lemma, Quadratic reciprocity, Quadratic reciprocity Law	
	3.3	Quadratic congruence's with composite moduli, The equation $x^2+y^2=z^2$, Pythagorean triple.	

4.0		**Number Theoretic Functions**	
	4.1	The Mobius function $\mu(n)$, The Eular Totient function $\varphi(n)$, A relation connecting μ and φ, The product formula for $\varphi(n)$	**15**
	4.2	Dirichlet product of arithmetic function, Dirichlet inverses and Mobius inversion formula, The Managoldt function $\Lambda(n)$, Multiplicative function	
	4.3	Liouville's function, The divisor function, Generalized convolution, Formal power series	
	4.4	The Bell series of an arithmetic function, bell series and Dirichlet multiplication, derivatives of arithmetic function, The Selberg identity.	
		Total	**60**

Text Book:

1. **David M. Burton,** "Elementary Number Theory" Tata McGraw-Hill Pub. VI Edition.
2. **Tom M. Apostol**, "Introduction to Analytic Number Theory" Springer International Student Edition, Narosa, Publishing house 1989.

Module I - Chapter 4, Chapter 5- Art 5.1 to 5.3.

Module-II - Chapter 8.

Module-III - Chapter 9, Chapter12 - Art 12.1.

Module-IV - Chapter 2.

Reference Books:

1. **J. P. Serre, "**A course in arithmetic", GTM Vol.7, Springer Verlage 1973.
2. **Niven and H. S. Zuckerman**, "An Introduction to the Theory of Numbers", Wiley Eastern Limited, New Delhi, 1976.
3. **Pundir and Pundir** , "Theory of Numbers",Pragati Prakashan Meerut
4. **M G Nadkarni and J S Dani ,** "Number Theory", Tata McGraw Hill Publishing Company Limited

M.A/M. Sc. Second Year Semester-III *(Level 6.0)*

DSE(A)-3

SMATE501 (A): Integral Transforms (4Cr)

Course objectives: The objective of this course is to introduce students the different types of integral transforms which are commonly used, their formulation concerned to real world problems, their evaluation and applications to solve ordinary and partial differential equations.

Course outcomes:

After completing this course, the student will be able to:

CO1: Classify the different types of integral transforms they come across.

CO2: Formulate the physical problem under consideration in terms of different types of ordinary and partial differential equations with initial and boundary conditions.

CO3: Solve the initial value problems and boundary value problems using the appropriate integral transform.

CO4: Analyze the nature of the solution of the initial value problems and boundary value problems.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1. 0		**Laplace Transform**	**17**
	1.1	Introduction, The Laplace Transform of some typical Functions	
	1.2	Basic operational properties,	
	1.3	Transforms of more complicated functions, The inverse Laplace Transform	
	1.4	Complex Inversion Formula, Additional Topics.	
2.0		**Applications of Laplace Transform**	**14**
	2.1	Applications involving Laplace Transform: Introduction	
	2.2	Evaluating integrals, Solutions of ODEs, Solutions of PDEs. The Mellin transform,	
	2.3	Evaluation of Mellin transform, Complex variable methods, Applications.	
3.0		**Fourier Transform**	**16**
	3.1	Fourier integrals and Fourier Transforms: Introduction	
	3.2	Fourier integral representations, Proof of the Fourier integral theorem, Fourier transform pairs	
	3.3	Properties of the Fourier Transform, The convolution integrals of Fourier, Transforms involving generalized functions.	

4.0		**Applications of Fourier Transform**	
	4.1	Applications involving Fourier transforms: Introduction	**13**
	4.2	Boundary value problems, Heat conduction in solids	
	4.3	The Hankel Transform: Introduction	
	4.4	Evaluation of Hankel Transform, Applications	
		Total	**60**

Text Book:

1. Larry C. Andrews, Bhimsen K. Shivamoggi, *Integral Transforms for Engineers*, Prentice Hall of India, New Delhi.

Scope: Module-I: Chapter 4 complete.

Module-II: Chapter 5, Sections 5.1 to 5.4, Chapter 6, Sections 6.1 to 6.4

Module-III: Chapter2, Sections 2.1 to 2.5, 2.7, 2.8

Module-IV Chapter 3, Sections 3.1 to 3.3, Chapter 7, Sections 7.1 to 7.3.

Reference Books:

1. J. K. Goyal, K. P. Gupta, *Integral Transforms*, Pragati Prakashan, Meerut.
2. A. R. Vasishtha, Dr. K. L. Gupta, *Integral Transforms*, Krishna Prakashan Mandir, Meerut.

M.A/M. Sc. Second Year Semester-III *(Level 6.0)*

DSE-3(B)

SMATE501 (B): Fluid Mechanics-I (4Cr)

Course objectives: The course introduces basic idea of various fluid flow, velocity and acceleration of fluid motion. The main objective of the course is to study Equation of continuity, Euler
equation, Bernoulli equation, effect of pressure on fluid flow, stream function, some two dimensional flows and applications to real life.

Course outcomes:

After completing this course, the student will be able to:

CO1: To visualize the fluid flow pattern.

CO2: Assimilate the meaning of continuity equation.

CO3: Solve flow problems.

CO4: Acquire command on stream function.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1. 0		**Kinematics of Fluids in Motion**	**15**
	1.1	Real fluids and Ideal fluids, Velocity of fluid at a point, Streamlines and Path lines	
	1.2	Steady and unsteady flows, the velocity potential, the vorticity vector.	
	1.3	Local and particle rates of change, the equation of continuity, worked examples.	
	1.4	Acceleration of fluid, Conditions at a rigid boundary, general analysis of fluid motion.	
2.0		**Equations of Motions of a Fluid**	**15**
	2.1	Pressure at a point in a fluid at rest, Pressure at a point in a moving fluid,	
	2.2	Conditions at a boundary of two inviscid immiscible fluids, Eulers equation of motion	
	2.3	Bernoulli's equation, Mechanism of Pitot Tube and Venturi meter, worked examples.	
3.0		**Equations of Motion of a Fluid**	**15**
	3.1	Discussion of the case of steady motion under conservative body forces, some potential theorems (statement only),	
	3.2	Some flows involving axial symmetry, some special two dimensional flows	

	3.3	Impulsive motion, some further aspects of vortex motion.	
4.0		**Some Two Dimensional Flows**	**15**
	4.1	Meaning of two dimensional flow, use of cylindrical polar Coordinates	
	4.2	The Stream function	
	4.3	The complex velocity potentials for standard two-dimensional flows	
	4.4	Uniform stream, line sources and line sinks, line doublets, line vortices, some worked examples.	
		Total	**60**

Text Book:

Text book of Fluid Dynamics, F Charlton, Reprint 1998, C B S Publishers and distributors, Delhi –110 002

Scope :

Module-I Chapter 2, 2.1-2.11

Module-II Chapter 3, 3.1-3.6

Module-III Chapter 3, 3.7-3.12

Module-IV Chapter 5, 5.1-5.6

Reference Books:

1, G.K. Batchelor- An Introduction to Fluid Mechanics(Foundation Book-New Delhi 1994)

2. W.H. Besaint and A.S. Ramsey – A Treatise on Hydro Mechanics Part II, CBS Publisher-1998.

3. S.W.Yuan – Foundations of Fluid Mechanics, Prentice Hall of India Pvt. Ltd- New Delhi 1976.

M.A/M. Sc. Second Year Semester-III *(Level 6.0)*

DSE-3(C)

SMATE501 (C): Fractional Calculus and its Applications-I (4Cr)

Course objectives: This course introduces some special functions of the fractional calculus, Riemann- Liouville fractional derivative, Caputo's fractional derivative, Laplace, Fourier, and Mellin transforms of fractional derivatives, Existence and uniqueness theorem as a method of solution.

Course outcomes:

After completing this course, the student will be able to:

CO1: Understand the Gamma, Mittag-Leffler, Wright functions of the fractional calculus

CO2: Study Riemann-Liouville and Caputo's fractional derivative.

CO 3: Analyze the integral transform methods of solution of fractions differential equations.

CO4: Study existence and uniqueness theorem of fractions differential equations.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1. 0		**Beta and Gama Functions**	**15**
	1.1	Definition of Gamma function and Beta function, Some properties of Gamma and Beta functions,	
	1.2	Relation between Gamma and Beta functions, Definition of Mittag-Leffler functions of one and two parameters	
	1.3	Relations of Mittag-Leffler function in two parameters, Wright function,	
	1.4	Definition of Wright function, Integral relation and relation to other functions.	
2.0		**Fractional Derivatives**	**15**
	2.1	Grunwald-Letnikov fractional derivatives, Riemann-Liouville fractional derivative	
	2.2	Some other approaches-Caputo's fractional derivative, Generalized functions approach,	
	2.3	Sequential fractional derivatives, Left and right fractional derivatives.	
3.0		**Integral Transform of Fractional Derivatives**	**15**
	3.1	Laplace transform of fractional derivatives	
	3.2	Fourier transform of fractional derivative	
	3.3	Mellin transform of fractional derivative.	

4.0		**Linear Fractional differential equations**	**15**
	4.1	Linear Fractional differential equations	
	4.2	Fractional differential equations of a general form	
	4.3	Existence and uniqueness theorem as a method of solution	
	4.4	Dependence of a solution on initial conditions.	
		Total	**60**

Text Book:

1. **Igor Podlubny**, "Fractional Differential Equations", Academic Press, San Diego, California, 92101-4495, USA

Scope: Module -I - Chapter 1.

Module-II - Chapter 2- Art 2.1 to 2.6.

Module-III - Chapter 2- Art 2.7 to 2.10.

Module-IV - Chapter 3.

Reference Books:

1. **Miller K. S. and Ross B**., "An Introduction to Fractional Calculus and Fractional Differential Equations", New York, John Wiley, 1993.
2. **Oldham K. B. and Spanier J.**, "The Fractional Calculus", New York, Academic Press, 1974.

M.A/M. Sc. Second Year Semester-III *(Level 6.0)*

DSE(D): SMATE501 (D): Fuzzy Sets and their Applications-I(4Cr)

Course objectives: This course introduces the concepts of Crisp sets and fuzzy sets, operations on fuzzy sets and fuzzy relations.

Course outcomes:

After completing this course, the student will be able to:

CO1: Understand the concepts of Crisp sets and fuzzy sets.

CO2: Analyze the operations on fuzzy sets.

CO3: Discuss Crisp and fuzzy relation.

CO4: Study Fuzzy relation equation.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1. 0		**Introduction to Fuzzy Set**	**15**
	1.1	Introduction, Crisps Set: An Overview	
	1.2	The notation of fuzzy sets	
	1.3	Basic concepts of fuzzy sets	
	1.4	Classic Logic: An overview, Fuzzy logic.	
2.0		**Operations on Fuzy sets**	**15**
	2.1	General discussion	
	2.2	Fuzzy complement, Fuzzy union	
	2.3	Fuzzy intersection, combinations of operations, general aggregation operations.	
3.0		**Fuzzy Relations**	**15**
	3.1	Fuzzy Relations: Crisp and fuzzy relation	
	3.2	Binary relations,	
	3.3	Binary relation on a single set.	
4.0		**Fuzzy relation equation**	**15**
	4.1	Equivalence & similarity relations	
	4.2	Compatibility or Tolerance relations	
	4.3	Ordering, morphisms,	
	4.4	Fuzzy relation equation	
		Total	**60**

Text Book:

1. **George J. Klir & Tina A. Folger**, Fuzzy sets, uncertainty & information (Prentice Hall of India Pvt. Ltd.) Sixth Printing 2001.

Scope : Module-I Chapter 1.

Module-II Chapter 2.

Module-III Chapter 3 Art 3.1 to 3.3.

Module-IV Chapter 3 Art 3.4 to 3.8.

Reference Books:

1. **D. Drinkov, H. Hellendora & M. Reinfrank**, Introduction to Fuzzy control, Narosa Publishing House.
2. **H.J. Zimmermann**, Fuzzy Set Theory & Its Applications, Allied Publishers Ltd. New Delhi-1991.
3. **G. J. Klir & B. Yuan,** Fuzzy Sets & Fuzzy Logic. Prentice Hall of India New Delhi-1995.

M.A/M. Sc. Second Year Semester-III *(Level 6.0)*

DSE-3(E)

SMATE501 (E): Coding Theory (4Cr)

Course objectives: This course introduces the concepts of linear codes and how one can construct the linear codes

Course outcomes:

After completing this course, the student will be able to:

CO1: Introduce coding theory and finite field structure

CO2: Study linear spaces over finite fields

CO3:To discuss bounds in Coding Theory

CO4: To construct linear codes

Curriculum Details:

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1. 0		**Introduction to Error detection, correction and decoding and Finite fields**	**22**
	1.1	Communication channels, Maximum likelihood decoding	
	1.2	Hamming distance, Nearest neighbour/minimum distance decoding,	
	1.3	Distance of a code	
	1.4	Fields, Polynomial rings, Structure of finite fields, Minimal polynomials.	
2.0		**Linear Code**	**13**
	2.1	Vector spaces over finite fields, Linear codes, Hamming	
	2.2	Weight Bases for linear codes, Generator matrix and parity-check matrix, Equivalence of linear codes	
	2.3	Encoding with a linear code, Decoding of linear codes	
3.0		**Bounds in Coding Theory**	**15**
	3.1	The main coding theory problem, Lower bounds, Sphere-covering bound	
	3.2	Gilbert–Varshamov bound, Hamming bound and perfect codes, Binary Hamming codes, q-ary Hamming codes,	
	3.3	Golay codes, Some remarks on perfect codes, Singleton bound and MDS codes, Plotkin bound.	
4.0		**Constructions of linear codes**	**10**
	4.1	Propagation rules	

	4.2	Reed–Muller codes	
	4.3	Subfield codes.	
		Total	**60**

Text Book:

1. **San Lingand Chaoping Xing**, Coding Thoery A first Course .Cambridge University Press

Scope : Module-I Chapter 2 and Chapter 3.

Module-II Chapter 4.

Module-III Chapter 5 Art 5.1 to 5.5.

Module-IV Chapter 6

Reference Books:

1. **E.R. Berlekemp,** Algebraic Coding Thoery , McGraw-Hill New York(1968) Publishing House.
2. **F J MacWilliams and N J A Sloane,** The Theory of Error –Correcting Codes, North Holland
3. **Lid and Pilz ,** Applied Abstract Algebra - 2nd Edition.
4. **R. Lidl, H.Neiderreiter** , Introduction to finite fields and their applications, Cambridge University Press.

M.A/M. Sc. Second Year Semester-III *(Level 6.0)*

Practical -3

SMATP501: Python Programming (2 Cr)

Course Objectives: The main objective of the course is to introduce Python Programming and use these skills to apply in the field of Mathematics

Course Outcomes:

After completing this course, the student will be able to:

CO1: Study python on different operating systems, variables, strings and comments.

CO2: Work with lists and understand difference between lists and dictionaries.

CO3: Study loops in python.

CO4: Learn functions, classes, files in python.

Curriculum Details:

loduleNo.	Unit No.	Topic	Hrs. Required to cover the contents
1. 0		**Getting Started, Variables and Simple Data Types**	**3T+8P**
	1.1	Setting Up your Programming Environment, Python on different Operating Systems, Troubleshooting	
	1.2	Running Python Programs from a terminal Variables, Strings, Numbers, comments	
	1.3	The Zen of Python	
2.0		**Introducing Lists, Working with Lists**	**3T+8P**
	2.1	What is a List? Changing, Adding and Removing Elements, organizing a List	
	2.2	Avoiding Index Errors When Working with Lists, Looping Through an Entire List	
	2.3	Avoiding Indentation Errors, Making Numerical Lists, Working with Part of a List, Tuples, Styling your Code	
3.0		**If Statements, Dictionaries**	**4T+8P**
	3.1	Conditional Tests, If Statements, Using if Statements with Lists	
	3.2	Styling your If Statements Working with Dictionaries	
	3.3	Looping through a dictionary, Nesting	
4.0		**User Input and While Loops, Functions and Classes**	**4T+6P**
	4.1	Input( ) Function, Introducing while loops, Using a while Loop with Lists and Dictionaries Defining a Function	
	4.2	Passing Arguments, Return Values, passing a List, Passing an Arbitrary Number of Arguments	
	4.3	Storing Your Function in Modules, Styling Functions.	
	4.4	Creating and Using a Class, Working with Classes and Instances	
		Total	**15T+30P**

Text Book

Python Crash Course by Eric Matthes, no starch press, San Francisco

Module-I Part I Chapter 1 and Chapter 2

Module-II Part I Chapter 3 and Chapter 4

Module -III Part I Chapter 5 and Chapter 6

Module -IV Part I Chapter 7, Chapter 8 and Chapter 9

Note: Module wise at least 3 practicals should be maintained in the form Record book

Reference Books:

1. **H. Bhasin,** Python Basics, MERCURY LEARNING AND INFORMATION Dulles, Virginia Boston, Massachusetts New Delhi
2. **Magnus Lie Hetland*, Beginning***-Python, Second Edition
3. **Martin C. Brown**, The Complete Reference Python
4. **Patrick Barry**, Head First Python
5. **Alex Martelli,** Learning Python, OReilly by Mark Lutz 5. Python in a Nutshell, O‟Reilly

M.A/M. Sc. Second Year Semester-III *(Level 6.0)*

Research Project -1

SMATR551: Research Project (4 Cr)

Course objectives:

- Identify and define a significant issue relevant to the discipline of the degree.
- Systematically collect relevant up-to-date information about the issue, either directly or from published studies or publicly available data
- Draw conclusions and make recommendations relevant to the issue that will contribute to current knowledge
- Write and present a report in accordance with academic standards at a postgraduate level

Course outcomes: Completing a project as part of M.Sc-II(Sem-III) is an opportunity to:

CO1: learn to read and interpret other people's research critically by doing own

CO2: This gives you an insight into the effects of practical difficulties and theoretical debates on published research.

CO3: Submit a paper for peer-reviewed publication. (If successful, this will give a boost to your c.v.)

CO4: Ccontinue his work for further research

At the beginning of semester-III allotment of research supervisor to student (1 student 1 project) will be done. After finalization of research topic, supervisor will ask to do literature survey on the related topic. The corresponding students must write and submit (within two weeks) synopsis of his work and literature survey made during this semester. 20 marks for internal and 80 for semester evaluation.

Internal Assessment

Research Synopsis submission (Within first two week of semester-III)	PPT 1 (7th week of semester - III)	PPT2 (13th week of semester - III)	Total marks
6	7	7	20

External Assessment

Project Write up	Paper presented /Published on literature survey	Final PPT Presentation	Viva/Oral	Total marks
40	15	15	10	80*

* Note: External examiner should evaluate write up according to following point

1. Suitable Topic chosen for Research
2. Research methodology used.
3. Literature survey carried out during semester.
4. Originality/uniqueness of work done.
5. Proper citation and referencing.
6. Conclusion/Results in the project
7. Presentation/Publication of students work

M. Sc. Second Year Semester-IV *(Level 6.0)*

DSC-10

SMATC551: Numerical Analysis (4Cr)

Course objectives: To introduce the concepts and to develop working knowledge on Iteration Methods to Solve the Equations, Rate of Convergence of Iteration Methods, Solution of the System of Equations by using Different Direct and Iteration Methods, Eigen Value Problems, Bounds of Eigen Values, Interpolation, Lagrange, Iterated and Newton's Interpolations of Different Orders, Least Square Approximation.

Course outcomes:

After completing this course, the student will be able to:

CO1: Identify the roots of equations and to obtain them by using different iteration Methods and to obtain rate of convergence of Iteration Methods.

CO2: Analyze the direct methods to solve the the system of n equations in n unknowns by using different direct methods

CO3: Identify the Iteration Methods to Solve the System of n Equations in n Unknowns,Eigen Value problems and to obtain Bounds on Eigen Values.

CO4: Provide information on Interpolations and Approximations for the given function.

Curriculum Details:

Module No.	UnitNo.	Topic	Hrs. Required to cover the contents
1. 0		**Transcendental and Polynomial equations**	**15**
	1.1	Iteration Methods based on first degree equation: Secant and Regula Falsi Method	
	1.2	Secant and Regula Falsi Method: Muller Method, Chebyshev Method,	
	1.3	Rate of Convergence.	
2.0		**Direct Methods to Solve the System of n Equations in n Unknowns**	**15**
	2.1	Some basic definitions: Square, Diagonal, Lower Triangular, Upper Triangular, Identity and Null Matrix. Symmetric and Skew-Symmetric Matrix	
	2.2	Hermitian and Skew- Hermitian Matrix, Orthogonal Matrix, Permutation Matrix, Property 'A', tri-diagonal and band Matrix, Positive definite Matrix, System of n	

		Equations in n unknowns.	
	2.3	Direct methods to solve the system of n equations in n unknowns, Gauss elimination method, Jordan elimination Method, Triangularization Method, Cholesky Method, Partition Method, Model Problems.	
3.0		**Iteration methods to solve the system of n equations in n unknowns**	**15**
	3.1	Introduction, Iteration methods to solve the system of n equations in n unknowns: Gauss-Seidel Method,	
	3.2	Jacobi Iteration Method, Successive Over Relaxation Method,	
	3.3	Model Problems, Iteration Method to Obtain Inverse of a Square Matrix.	
4.0		**Interpolations**	**15**
	4.1	Introduction, Vandermonde's Determinant, Interpolating Polynomial, Lagrange Interpolating Polynomial,	
	4.2	Newton's Divided Difference Interpolating Polynomial,	
	4.3	Aitken's Interpolating Polynomial, Quadratic Interpolation.	
	4.4	Higher Order Interpolating Polynomials.	
		Total	**60**

Text Book:

1. **M. K. Jain, S. R. K. Iyengar, R. K. Jain**, "Numerical methods for Scientific and Engineering Computations." New Age International Limited Pub.

Scope: Module I - Chapter 2 Art 2.1 to 2.5.

Module II - Chapter 3 Art 3.1 to 3.3.

Module III - Chapter 3 Art 3.4.

Module IV - Chapter 4 Art 4.1 to 4.4.

Reference Books:

1. **S. S. Sastry**, "Introductory methods of Numerical Analysis" Prentice- Hall of India Private Ltd. (Second Edition) 1997.
2. **E. V. Krishnamurthi & Sen**. "Numerical Algorithm," Affiliate East. West press. Private Limited 1986.

M. Sc. Second Year Semester-IV *(Level 6.0)*

DSC-11

SMATC552: Classical Mechanics (4Cr)

Course objectives: To understand the concepts of Mechanics of system of particles, generalized coordinates, Degree of freedom. To Study mechanics developed by Newton, Lagrange and Hamilton and their applications. To solve motivating problems of calculus of variations.

Course outcomes:

After completing this course, the student will be able to:

CO1: Understand D' Alembert's Principle and applications of the Lagrangian Formulation.

CO2: Distinguish the concept of the Hamilton Equations of Motion and the Principle of Least Action.

CO3: Analyze the Fundamental lemma of calculus of variations.

CO4: Solve problems of calculus of variations using Euler's equation.

Curriculum Details:

Module No.	UnitNo.	Topic	Hrs. Required to cover the contents
1. 0		**Survey of Elementary Principles**	**15**
	1.1	Mechanics of System of particles, generalized co-ordinates, Degree of freedom, Holonomic and Non-holonomic system	
	1.2	Scleronomic and Rheonomic system, D'Alembert's principles and Lagrange's Equation of Motion	
	1.3	Different forms of Lagrange's Equation, Generalized Potential,	
	1.4	Conservative fields and its Energy Equation, Application of Lagrange's formulation.	
2.0		**Variational Principles and Lagrange's Equation**	**15**
	2.1	Hamilton's Principle, Hamilton's canonical Equations, Lagrange's Equation from Hamilton's Principle,	
	2.2	Extension of Hamilton's Principle to Non-holonomic systems, Application of Hamilton's formulation, cyclic coordinates and conservation theorems	
	2.3	Routn's Procedure, Hamilton's Equations from variational principle, principle of least Action.	
3.0		**Elements of the Theory**	**15**
	3.1	Functional, Linear Functional, Fundamental lemma of calculus of variations	

	3.2	Simple variational problems, The variation of functional	
	3.3	The extremum of functional, Necessary condition for Extreme, Euler Equation	
4.0		**Calculus of Variations**	
	4.1	Eulers Equation of several variables, Invariance of Euler Equation	**15**
	4.2	Motivating Problems of calculus of variation, Shortest Distance, Minimum surface of Revolution,	
	4.3	Brachistochrone Problem, Isoperimetric Problem, Geodesic, Variational problems in Parametric form	
	4.4	Generalization of Euler Equation, Variational Problems with subsidiary conditions.	
		Total	**60**

Text Book:

1. **H. Goldstein, Charles Poole, John Sabko**, "Classical Mechanics", Pearson 3rd Edition 2002.

   Scope: Module-I Chapter 1.

   Module-II Chapter 8.

2. **I. M. Gelfand and S. V. Fomin** "Calculus of Variations" Prentice Hall.

   Scope: Module-III Chapter 1.

   Module-IV Chapter 2.

Reference Books:

1. **N. Rana and B. Joag**, "Classical Mechanics", Tata McGraw Hill 1991.
2. **A.S. Ramsey**, "Dynamics Part II" The English Language Book Society and Cambridge University press, 1972.

M.A/M. Sc. Second Year Semester-IV*(Level 6.0)*

DSE-4(A)

SMATE551 (A): Integral Equations (4Cr)

Course objectives: Many physical problems that are usually solved by differential equation methods can be solved more effectively by integral equation methods. Such problems abound in applied mathematics, theoretical mechanics, and mathematical physics. This course enables the students to get the detailed idea about the integral equation, its classification, different types of kernals, the relationship between the integral equations and ordinary differential equations and how to solve the linear integral equations by different methods with some problems which give rise to integral equations.

Course outcomes:

After completing this course, the student will be able to:

CO1: Acquire sound knowledge of different types of Integral equations**.**

CO2: Obtain integral equations from ODEs and PDEs arising in applied mathematics and different engineering branches and solve accordingly using various method of solving integral equation

CO3: Demonstrate a depth of understanding in advanced mathematical topics in relation to geometry of curves and surfaces.

CO4: Apply the knowledge of integral transformation like Laplace transformation, Fourier transformation to solve different types of integral equation.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1. 0			**15**
	1.1	Preliminary Concepts, Integral Equation: Definition, Linear and nonlinear Integral Equations, Fredholm Integral Equations	
	1.2	Volterra Integral Equations, Singular Integral Equations, Special Kinds of Kernels, and classification of integral equations, Special kinds of kernels,	
	1.3	Convolution integrals, Conversion of an initial value problem into a Volterra integral equation,	
	1.4	Conversion of a boundary value problem into a Fredholm integral equation, Homogeneous integral equations of the second kind with separable kernel.	
2.0			**15**
	2.1	Solution of Fredholm integral equations of the second kind with separable kernel, Fredholm alternative,	

	2.2	An approximate method Method of successive approximation: Iterated kernel, Resolvent kernel, Solution of Fredholm and Volterra integral equations of the second kind by the method of successive substitutions	
	2.3	Solution of Fredholm and Volterra integral equations of the second kind by the method of successive approximations: Neumann series.	
3.0			
	3.1	Integral equations with symmetric kernels: Regularity conditions, Complex Hilbert space, An orthonormal system of functions	**15**
	3.2	Fundamental properties of eigen values and eigen functions for symmetric kernels. Expansion in eigen functions and bilinear form	
	3.3	Hilbert- Schmidt theorem and some immediate consequences, Definite Kernels and Mercer's theorem	
4.0			
	4.1	Singular integral equations, The solution of Abel integral equation,	**15**
	4.2	General form of Abel integral equation, Another general form of Abel integral equation,	
	4.3	Integral transform method	
	4.4	Application of Laplace transform to solve Volterra integral equations with convolution type kernels, Examples.	
		Total	**60**

Text Book:

1. **Dr. M. D. Raisinghania**, *Integral Equations and Boundary Value Problems*, S. Chand and Company Pvt. Ltd., New Delhi.

Scope:

ModuleI: Chapter 1 complete, Chapter 2 complete, Chapter 3 complete,
ModuleII Chapter 4 complete, Chapter 5 sections 5.1 to 5.15
Module-III Chapter 7 sections 7.1 to 7.5
Module-IV Chapter 8 sections 8.1 to 8.4, Chapter 9 section 9.1 to 9.5

Reference Books:

1. **R. P. Kanwal**, Linear Integral Equantions Theory and Technique, Academic Press, Inc., New York.
2. **S. G. Mikhlin**, Linear integral equations (Translated from Russian) "Hindustan Book Agency 1960.
3. **B. L. Moiseiwitsch**, Integral Equations, Longman, London & New York.
4. **M. Krasnov, A Kiselev, G. Makaregko**, Problems and Exercises in integral equations (Translated from Russian) by George Yankovsky) MIR Publishers Moscow, 1971.

M.A/M. Sc. Second Year Semester-IV *(Level 6.0)*

DSE-4(B)
SMATE551(B): Fluid Mechanics-II(4Cr)

Course objectives: The aim of this course is to study two-dimensional image system, Milne Thomson circle theorem, theorem of Blasius, concepts of gas dynamics, stress strain relations, uniqueness theorem, important relations related to Navier-Stokes equations and various applications in all fields.

Course outcomes:

After completing this course, the student will be able to:

CO1: Apply Milne-Thomson circle theorem

CO2: Identify appropriate governing equation for particular flow.

CO3: Explain stress strain relations.

CO4: Evaluate the velocity of fluid flow.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1. 0		**Two dimensional image system**	**15**
	1.1	Two dimensional image system	
	1.2	The Milne- Thomson circle theorem	
	1.3	Applications of the circle theorem	
	1.4	The theorem of Blasius, some worked examples.	
2.0		**Gas Dynamics**	**15**
	2.1	Compressibility effects in real fluids, The elements of wave motion.	
	2.2	The speed of sound in a gas, Equation of motion of a gas, Subsonic, sonic and Supersonic flows	
	2.3	Isentropic gas flow, Reservoir discharge through a channel of varying section, Shock waves.	
3.0		**Viscus Flow**	**15**
	3.1	Stress components in a real fluid, Relations between Cartesian components of stress, Translational motion of fluid element	
	3.2	The rate of strain quadratic and principle stresses, Some further properties of the rate of strain quadratic, Stress analysis in fluid motion	
	3.3	Relation between stress and rate of strain, The coefficient of viscosity and laminar flow. The Naiver Stokes equations of motion of a viscous fluid.	
4.0		**Viscus Flow continued …**	**15**
	4.1	Flow between two parallel planes, Steady flow through	

		tube of uniform circular cross section	
	4.2	Some solvable problems in viscous flow, Steady viscous flow between concentric rotating cylinders.	
	4.3	Uniqueness theorem, Diffusion of vorticity, Energy dissipation due to viscosity	
	4.4	Steady flow past a fixed sphere, Prandtl's Boundary Layer.	
		Total	**60**

Text Book:

1. **Text book of Fluid Dynamics, by F Charlton**, Reprint 1998, C B S Publishers and distributors, Delhi – 110 002

Scope: Module-I Chapter 5, 5.7 to 5.9

Module-II Chapter 7, 7.1-7.7

Module-III Chapter 8, 8.1-8.9

Module-IV Chapter 8, 8.10-8.13

Reference Books:

1. **G.K. Batchelor-** An Introduction to Fluid Mechanics (Foundation Book-New Delhi 1994)
2. **W.H. Besaint and A.S. Ramsey** – A Treatise on Hydro Mechanics Part II, CBS Publisher-1998.
3. **S.W. Yuan** – Foundations of Fluid Mechanics, Prentice Hall of India Pvt. Ltd- New Delhi 1976

M.A/M. Sc. Second Year Semester-IV *(Level 6.0)*

DSE-4(C)

SMATE551 (C): Fractional Calculus and its Applications-II (4Cr)

Course objectives: This course introduces the concept of fractional green's functions, other methods for the solution of fractional order equations, numerical evaluation of fractional derivative numerical solution of fractional differential equations.

Course outcomes:

After completing this course, the student will be able to:

CO1: Study the solution of the initial value problem for the Ordinary fractional linear differential equation with constant coefficients using only its Green's function.

CO2 : Understand the different methods for the solution of fractional order equations.

CO3: Analyze the numerical evaluation of fractional derivatives.

CO4: Study the numerical solution of fractional differential equations.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1. 0			**15**
	1.1	Definition and some properties, one term equation.	
	1.2	Two term equation, Three term Equation.	
	1.3	Three term equation	
	1.4	Four term equation, general Case:n-term equation.	
2.0			**15**
	2.1	The Mellin transform method.	
	2.2	Power series method, Babenko's symbolic calculus Method.	
	2.3	Method of orthogonal polynomials.	
3.0			**15**
	3.1	Riemann-Liouville and Grunwald-Letnikov definitions of the fractional order derivatives.	
	3.2	Approximation of fractional derivatives, the short memory principle, order of approximation, computation of coefficients	
	3.3	Higher order approximations calculations of heat load intensity, finite part integrals and fractional derivatives.	

4.0			
	4.1	Initial conditions: Which problem to solve?, Numerical solution.	**15**
	4.2	Numerical solution, examples of numerical solutions	
	4.3	Examples of numerical solutions	
	4.4	The short memory principle in initial value problems for fractional differential equations.	
		Total	**60**

Text Book:

1. **Igor Podlubny**, "Fractional Differential Equations", Academic Press, San Diego, California, 92101-4495, USA

   Scope: Unit I - Chapter 5.

   Module-II - Chapter 6.

   Module-III - Chapter 7.

   Module-IV - Chapter 8.

Reference Books:

1. **Miller K.S. and Ross B**., "An Introduction to Fractional Calculus and Fractional Differential Equations", New York, John Wiley, 1993.
2. **Oldham K.B. and Spanier J.**, "The Fractional Calculus", New York, Academic Press, 1974.

M.A/M. Sc. Second Year Semester-IV *(Level 6.0)*

DSE-4(D)

SMATE551 (D): Fuzzy Sets and their Applications-II

Course objectives: This course introduces the concepts of Fuzzy measures, Uncertainty & Information and applications of fuzzy sets.

Course outcomes:

After completing this course, the student will be able to:

CO1: Understand the concepts of fuzzy measures.

CO2: Study types of uncertainty.

CO:3 Discuss Uncertainty & information and complexity.

CO4: Study the application of Fuzzy in different fields.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1. 0	1	**Fuzzy Measure**	**15**
	1.1	General discussion	
	1.2	Belief & plausibility measures, Probability measures	
	1.3	Possibility and necessity measures	
	1.4	Relationship among classes of fuzzy measures.	
2.0	2	**Classical measure of uncertainty**	**15**
	2.1	Uncertainty & Information, Types of uncertainty	
	2.2	Measures of fuzziness	
	2.3	Classical measure of uncertainty, Measures of dissonance.	
3.0	3	**Measure of non specificity**	**15**
	3.1	Measure of non specificity	
	3.2	Uncertainty & information and complexity	
	3.3	Principles of uncertainty and information.	
4.0	4	**Applications**	**15**
	4.1	Applications: General discussion	
	4.2	Natural, life & Social, Sciences,	
	4.3	Engineering, Medicine, Management & decision making	
	4.4	Computer Science, Systems sciences, other applications.	
		Total	**60**

Text Book:

1. **George J. Klir & Tina A. Folger**, Fuzzy sets, uncertainty & information (Prentice Hall of India Pvt. Ltd.) Sixth Printing 2001.

Scope : Module-I Chapter 4.

Module-II Chapter 5 Art 5.1 to 5.4.

Module-III Chapter 5 Art 5.5 to 5.9.

Module-IV Chapter 6

Reference Books:

1. **D. Drinkov, H. Hellendora & M. Reinfrank**, Introduction to Fuzzy control, Narosa Publishing House.
2. **H.J. Zimmermann**, Fuzzy Set Theory & Its Applications, Allied Publishers Ltd. New Delhi-1991.
3. **G.J. Klir & B.Yuan,** Fuzzy Sets & Fuzzy Logic.Prentice Hall of India New Delhi-1995

M.A/M. Sc. Second Year Semester-IV *(Level 6.0)*

DSE-4(E)

SMATE501 (E): Cryptography(4Cr)

Course objectives:

The objective of the course is to include new concepts and techniques, the cryptographic applications of number theory and algebraic number theory

Course outcomes:

After completing this course, the student will be able to:

CO1: Effectively express the concepts and results of Number Theory.

CO2: Arithmetic Operations in Finite Fields and able to construct finite field

CO3: Get a basic knowledge in Cryptography

CO4:Discuss cryptosystem over finite fields

Curriculum Details:

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1. 0	1	**Number Theory and Time estimates required for Cryptography**	**15**
	1.1	The big Oh notation, time estimates for doing addition, subtraction, multiplication, division.	
	1.2	Euclidean Algorithm and the time estimate to find the greatest common divisor of two integers, extended Euclidean algorithm	
	1.3	Properties of congruences: addition, multiplication, subtraction and division	
	1.4	solution of linear congruences, modular exponentiation by repeated squaring method	
2.0	2	**Fundamental Theorems**	**15**
	2.1	Fermat's little theorem, Euler's totient function, Euler's theorem Primitive roots	
	2.2	Finite fields: Primitive polynomials, Irreducible polynomials	
	2.3	Time estimations for doing arithmetic operations in finite fields, Construction of finite fields	
3.0	3	**Classical Cryptosystems**	**15**
	3.1	Shift cipher, Affine cipher, Substitution cipher, Vigenere cipher, Hill cipher, permutation cipher	
	3.2	Public Key cryptography: One way function, Trap door Functions	

	3.3	Concept of public key cryptography, RSA, Digital signature scheme	
4.0	4	**Primality Testing and Integer Factorization**	**15**
	4.1	Primality testing: pseudo primes, Rabin Miller probabilistic primality test, Carmichael numbers	
	4.2	Factoring algorithms: Pollard's rho method, Pollard's p-1 method, Fermat's factorization method	
	4.3	Discrete algorithm, Diffie-Hellman Key exchange protocol	
	4.4	El Gamal cryptosystem over prime field and finite fields, El Gamal digital signature scheme	
		Total	**60**

Text Book:

Koblitz, N. (1994) A course in Number Theory and Cryptography, (Second Ed.), Springer-Verlag.

Module-I Chapter 1 : 1 , 2 , 3

Module-II Chapter 1 : 4, Chapter 2 : 1, 2

Module-III Chapter 3 : 1 , 2 Chapter 4 : 1, 2

Module-IV : Chapter 4 : 3, 4 Chapter 5 : 1, 2, 3

Reference Books:

1. Stinson, D. R. (1995) Cryptography: Theory and Practice, CRC Press series on Discrete Mathematics and its applications.

2. Yan, S. Y. (2003) Primality Testing and Integer Factorization in Public-Key Cryptography, Springer

M.A/M. Sc. Second Year Semester-IV *(Level 6.0)*

Practical -4

SMATP551: MATLAB Programming (2 Cr)

Course Objectives: The main objective of the course is to introduce basics of MATLAB programming and use these skills to so solve some problems of Numerical Analysis

Course Outcomes:

After completing this course, the student will be able to:

CO1: Discus logical, relational, Conditional, loops, etc. statements of MATLAB

CO2: Define user defined function and function files

CO3: Apply programming in Curve fitting and Interpolation

CO4:Do programming in Mathematics Applications

Curriculum Details:

loduleNo.	Unit No.	Topic	Hrs. Required to cover the contents
1. 0		**Programming in MATLAB**	**3T+8P**
	1.1	Relational and Logical Operators	
	1.2	Conditional Statements	
	1.3	The Switch-Case Statement, Loops, Nested Loops and Nested Conditional Statements	
	1.4	The Break and Continue Commands, Examples of MATLAB Applications.	
2.0		**User-Defined Functions and Function Files**	**3T+8P**
	2.1	Creating A Function File, Structure of A Function File, Function Definition Line	
	2.2	Input and Output Arguments, The H1 Line and Help Text Lines, Function Body	
	2.3	Local and Global Variables Saving A Function File Using A User-Defined Function Examples of Simple User-Defined Functions	
3.0		**Polynomials, Curve Fitting, and Interpolation**	**4T+8P**
	3.1	Polynomials	
	3.2	Curve Fitting	
	3.3	Interpolation	
4.0		**Applications in Numerical Analysis**	**4T+6P**
	4.1	Solving an Equation with One Variable	
	4.2	Finding A Minimum or A Maximum of a Function , Numerical Integration	
	4.3	Ordinary Differential Equations	
	4.4	Examples of MATLAB Applications	
		Total	**15T+30P**

Text Book

Amos Gilat, MATLAB An Introduction with Applications, Fourth Edition JOHN WILEY & SONS, INC.

Module-I Chapter 6

Module-II Chapter 7 Article 7.1 to 7.5

Module -III Chapter 8 Article 8.1 to 8.3

Module -IV Chapter 9

Note : Module wise at least 4 practical's should be maintained in the form Record book

Reference Books:

1. **Rudra Pratap**,"Getting Started with MATLAB 7"Oxford University Press
2. *Naresh M. Chadha, "Programming In Matlab : With Applied Numerical Methods For Engineers And Scientists" Notion Presss*
3. *Stephen J Chapman , "MATLAB Programming for Engineers" Cenage*

M.A/M. Sc. Second Year Semester-IV *(Level 6.0)*

Research Project -2

SMATR551: Research Project (6 Cr)

Course objectives:

- Identify and define a significant issue relevant to the discipline of the degree.
- Systematically collect relevant up-to-date information about the issue, either directly or from published studies or publicly available data
- Draw conclusions and make recommendations relevant to the issue that will contribute to current knowledge
- Write and present a report in accordance with academic standards at a postgraduate level

Course outcomes: Completing a project as part of M.Sc-II(Sem-IV) is an opportunity to:

CO1: learn to read and interpret other people's research critically by doing own

CO2: This gives you an insight into the effects of practical difficulties and theoretical debates on published research.

CO3: Submit a paper for peer-reviewed publication. (If successful, this will give a boost to your c.v.)

The student will continue his research project allotted during semester -III in the fourth semester, however supervisor must ask to do field visit/survey (if applicable) during winter vacation. Individual students will do two power point presentation of his work and publish/present his work national/international. The corresponding students must submit his project report at the time of summer examination .30 marks for internal and 120 for semester end evaluation.

Internal Assessment

PPT 1 (7th week of semester-IV)	PPT2 (12th week of semester-IV)	Progress report and attendance (weekly)	Total Internal Marks
10	10	10	30

External Assessment

Final Project Report	Paper presented /Published	Final PPT Presentation	Viva/Oral	Total marks
60	20	20	20	*120

*Note: External examiner should evaluate write according to following point

8. Suitable Topic chosen for Research
9. Research methodology used.
10. Literature survey carried out during semester -III
11. Originality/uniqueness of work done.
12. Proper citation and referencing.
13. Conclusion/Results in the project
14. Presentation/Publication of students work

Guidelines for Course Assessment:

A. Continuous Assessment (CA) (20% of the Maximum Marks):

This will form 20% of the Maximum Marks and will be carried out throughout the semester. It may be done by conducting **Two Tests** (Test I on 40% curriculum) and **Test II** (remaining 40% syllabus). Average of the marks scored by a student in these two tests of the theory paper will make his **CA** score (col. 6).

B. End Semester Assessment (80% of the Maximum Marks):

(For illustration we have considered a paper of 04 credits, 100 marks and need to be modified depending upon credits of an individual paper)

1. **ESA Question paper will consist of 6 questions, each of 20 marks.**
2. **Students are required to solve a total of 4 Questions.**
3. **Question No.1 will be compulsory and shall be based on entire syllabus.**
4. Students need to solve **ANY THREE** of the remaining Five Questions (Q.2 to Q.6) and shall be based on entire syllabus.

Note: **Number of lectures required to cover syllabus of a course depends on the number of credits assigned to a particular course. One credit of theory corresponds to 15 Hours lecturing and for practical course one credit corresponds to 30 Hours. For example, for a course of two credits 30 lectures of one hour duration are assigned, while that for a three credit course 45 lectures.**

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