Programme and Course Structure

Department of Mathematics & Data Science

Sharda School of Engineering & Science

M.Sc. (Mathematics)

Programme Code: SBR0301

Batch: 2025-27

1.1 Vision, Mission and Core Values of the University

Vision of the University

To serve the society by being a global University of higher learning in pursuit of academic excellence, innovation and nurturing entrepreneurship.

Mission of the University

1. Transformative educational experience.
2. Enrichment by educational initiatives that encourage global outlook.
3. Develop research, support disruptive innovations and accelerate Entrepreneurship.
4. Seeking beyond boundaries.

Core Values

1.Integrity
2. Leadership
3.Diversity
4.Community

1.2 Vision and Mission of the School

Vision of the School

Achieving academic excellence in the realm of basic and engineering sciences to address the global challenges and to become global leaders.

Mission of the School

1. To impart basic, advanced and transformative knowledge and skills in science and technology.
2. To strengthen capacity and capabilities in cutting-edge technology and research.
3. To nurture multidisciplinary research and entrepreneurship temperament for developing innovative solutions to global, societal and environmental challenges.
4. To foster multi-dimensional partnerships and collaborations for skill development and global employability.

Core Values

1.Integrity
2. Leadership
3. Diversity
4. Community

1.3 Vision and Mission Department of Mathematics

Vision of the Department

To become a globally recognized destination for education in mathematical sciences and research.

Mission of the Department

1. To develop mathematical skills in students and make them employable across a wide range of professions and promote interest in research.
2. To develop entrepreneurial skills in students by encouraging critical thinking, innovation, and interdisciplinary applications of mathematics, data science and statistics.
3. To develop skills for the applications of mathematics, data science and statistics in the various fields.

Core Values

1. Integrity
2. Leadership
3. Diversity
4. Community

1.4 Programme Educational Objectives (PEO's)

PEO1: To deliver deep subject knowledge in the courses of study to enable students to shine in various fields such as sciences, engineering and technology, IT etc.
PEO2: To develop positive attitude and skills to enable the students to become a multi facet personality.
PEO3: To prepare students for entrance examinations conducted by IIT's/Universities to pursue Ph. D. Programmes as well as NET, UGC-CSIR.
PEO4: To develop students to be excellent to be excellent communicators and team players.

1.4.1 Programme Outcomes (PO's)

PO1: Mathematical knowledge: Application of Mathematical knowledge in various fields of science, engineering and management etc.
PO2: Nature of Mathematics: Understand the concise, precise and rigorous nature of Mathematics.
PO3: Critical thinking: Develop the skill to think critically on abstract concepts of Mathematics.
PO4: Problem analysis: Develop the ability to analyze a problem logically and dissect into micro-parts and thus resolving the problem to accessible components.

PO5: Mathematical logic and Ethics: Formulates and develops mathematical arguments in logical manner and Realize and understand professional, ethical and cultural responsibilities.

1.4.2 Programme Specific Outcomes (PSO's)

PSO1 : Scientific thinking and logical abilities.

PSO2 : Application of Mathematical principles in practical situations and software developments.

PSO3 : Analyze any problem to micro-levels and solve the problem step by step.

PSO4 : Owning up responsibility for logical comprehension and preparedness for constant improvement.

1.4.2 Mapping of PEOs with Mission Statements:

PEO Statements	School Mission 1	School Mission 2	School Mission 3	School Mission 4	School Mission 5	School Mission 6
PEO1:	3	2	3	1	2	3
PEO2:	3	2	3	1	2	3
PEO3:	3	3	3	3	3	3
PEO4:	3	2	3	1	3	3

1.4.3 Mapping of Programme Outcome (PO's) Vs Programme Educational Objectives (PEO's)

	PEO1	PEO2	PEO3	PEO4
PO1	3	3	3	2
PO2	3	3	3	2
PO3	3	3	3	2
PO4	3	2	3	2
PO5	2	3	2	3
PSO1	2	2	3	2
PSO2	3	2	2	3
PSO3	3	3	2	3
PSO4	3	2	3	3

1. Slight (Low) *2. Moderate (Medium)* *3. Substantial (High)*

CURRICULUM & CREDIT FRAMEWORK FOR POSTGRADUATE PROGRAMMES (Academic Session 2025-26)

V.1.0 | 04.03.2025

Year	Sem.	Core Courses (CC)	Discipline Specific Electives (DSE) / Multi disciplinary Courses	Skill Enhancement Courses (SEC)	Research Projects / Dissertation	Course Level	Minimum Credits for the year	(Cummulative Minimum Credits) Required for Award of Diploma / Degree	
1-YEAR PG PROGRAMME (AFTER 4-YEAR UG PROGRAMME)									
Through Coursework (CW) + Research Work (RW)									
1	I	Th-2(5) or Th-2(4) + Pract-2(1) [10]	*Th-1(3) or Th-1(2) + Pract-1(1) [3]	RM&IPR-1(1) [1]	Dissertation I-1(6) (RBL-1) [6]	500	40	1 Year PG degree by CW+RW	
	II	Th-1(6) or Th-1(5) + Pract-1(1) [6]			Dissertation II-1(14) (RBL-2) [14]				
Through Coursework (CW)									
1	I	Th-2(5) or Th-2(4) + Pract-2(1) [10]	Th-1(5) or Th-1(4) + Pract-1(1) [5]	1(2)+ RM&IPR-1(1) [3]	Dissertation I-1(2) (RBL-1) [2]	500	40	1 Year PG degree by CW	
	II	Th-1(6)+Th-1(5) or Th-1(5)+Th-1(4)+ Pract-2(1) [11]	Th-1(6) or Th-1(5) + Pract-1(1) [6]		Dissertation II-1(3) (RBL-2) [3]				
Through Research Work (RW)									
1	I		*Th-1(3) or Th-1(2) + Pract-1(1) [3]	RM&IPR-1(1) [1]	Dissertation I-1(16) (RBL-1) [16]	-	40	1 Year PG degree by RW * Research Based Applied Courses	
	II		*Th-1(4) or Th-1(3) + Pract-1(1) [4]		Dissertation II-1(16) (RBL-2) [16]				
2-YEAR PG PROGRAMME (AFTER 3-YEAR UG PROGRAMME)									
1	I	Th-4(5) or Th-4(4) + Pract-4(1) [20]		CC-1(0) (Audit) [0]		400	40	PG Diploma after exit from 1st Year (Entry & Exit Option)	
	II		Th-2(4) or Th-2(3) + Pract-2(1) & (OE) Th-1(4) [12]	1(4) [4]	Project - 1(4) [4]				
OR									
1	I	Th-4(4)+Pract-4(1) [20]		1(4) [4]		400	40	PG Diploma after exit from 1st Year (Entry & Exit Option)	
	II		Th-2(4) or Th-2(3) + Pract-2(1) & (OE) Th-1(4) [12]	1(4) [4]		500			
Studetns who exit at the end of 1st year shall be awarded a Postgraduate Diploma									
2	III	Th-2(5) or Th-2(4) + Pract-2(1) [10]	*Th-1(3) or Th-1(2) + Pract-1(1) [3]	RM&IPR-1(1) [1]	Dissertation I-1(6) (RBL-1) [6]	500	40	2nd Year (3rd & 4th Semester)	2 Year PG degree by CW + RW
	IV	Th-1(6) or Th-1(5) + Pract-1(1) [6]			Dissertation II-1(14) (RBL-2) [14]				
2	III	Th-2(5) or Th-2(4) + Pract-2(1) [10]	Th-1(5) or Th-1(4) + Pract-1(1) [5]	1(2)+ RM&IPR-1(1) [3]	Dissertation I-1(2) (RBL-1) [2]	500	40	2nd Year (3rd & 4th Semester)	2 Year PG degree by CW
	IV	Th-1(6)+Th-1(5) or Th-1(5)+Th-1(4)+ Pract-2(1) [11]	Th-1(6) or Th-1(5) + Pract-1(1) [6]		Dissertation II-1(3) (RBL-2) [3]				
2	III		*Th-1(3) or Th-1(2) + Pract-1(1) [3]	RM&IPR-1(1) [1]	Dissertation I-1(16) (RBL-1) [16]	-	40	2nd Year (3rd & 4th Semester)	2 Year PG degree by RW * Research Based Applied Courses
	IV		*Th-1(4) or Th-1(3) + Pract-1(1) [4]		Dissertation II-1(16) (RBL-2) [16]				

*Courses shall be Research based / Lab based Training / Hands on Training Evaluation will be made as per Rubrics made by the Department/School and duly approved by the Dean Academic Affairs / Committee constituted for the purpose.

No. of Courses | No. of Credits | Total Credits in Block

Dean Academic Affairs
Sharda University, Greater Noida

Vice Chancellor
Sharda University
Plot No. 32-34, Knowledge Park-III
201310 (U.P.)

CURRICULUM & CREDIT FRAMEWORK FOR POSTGRADUATE PROGRAMMES (Academic Session 2025-26)						V.1.0		04.03.2025	
Year	Sem.	Core Courses (CC)	Discipline Specific Electives (DSE) / Multi disciplinary Courses	Skill Enhancement Courses (SEC)	Research Projects / Dissertation	Course Level	Minimum Credits for the year	(Cummulative Minimum Credits) Required for Award of Diploma / Degree	
1-YEAR PG PROGRAMME (AFTER 4-YEAR UG PROGRAMME)									
Through Coursework (CW) + Research Work (RW)									
1	I	MTT5301Abstract(5)+MTT5302Functional Analysis(5) [10]	*(3)MTT5303-(3)Graph Theory and its Applications [3]	MTT5310RM&IPR-1(1) [1]	MTR5352Dissertation I-1(6) [6] (RBL-1)	500	40	1 Year PG degree by CW+RW	
	II	MTT5408Operation Research and Industrial Applications+MTP5459(Lab)(1) [6]			Dissertation II-1(14) [14] MTR5455(RBL-2)				
Through Coursework (CW)									
1	I	MTT5301 Abstract(5)+MTT5302 Functional Analysis(5) [10]	MTT5304Number Theory with Cryptography(5) [5]	MTP5358 Python Programming Lab(2)+ RM&IPR-1(1) [3]	MTR5353Dissertation I-1(2) [2] (RBL-1)	500	40	1 Year PG degree by CW	
	II	MTT5409Advanced Graph Theory and Information Security(5)+ MTP5460 lab(1) +MTT5407Measure Theory(5) [11]	MTT5408Operation Research and Industrial Applications+MTP5459(Lab)(1) [6]	[6]	MTR5456Dissertation II-1(3) [3] (RBL-2)				
Through Research Work (RW)									
1	I		*MTT5305 Linear Programming(3) [3]	MTT5310RM&IPR-1(1) [1]	MTR5354Dissertation I-1(16) [16] (RBL-1)	-	40	1 Year PG degree by RW * Research Based Applied Courses	
	II		*MTT5303Graph Theory and its Applications(3) + MTP5460 lab(1) [4]		MTR5457Dissertation II-1(16) [16] (RBL-2)				
2-YEAR PG PROGRAMME (AFTER 3-YEAR UG PROGRAMME)									
1	I	MMT102(4)+MTT4102(4)+STT4704(4)+MTT4703(5) MTP4151(1)+STP4752(1)+MTP4152(1) [20]		CCP4001(0) (Audit) [0]		400	40	PG Diploma after exit from 1st Year (Entry & Exit Option)	
	II		MTT4204(3)+MTP4253(Lab) (1)+MMT106(4) & (OE) MMT107/MMT108/MMT204(4) [12]	MMT105 ODE, PDE(4) [4]	MTR4854Project(4) [4]				
OR									
1	I	MMT102(4)+MTT4102(4)+STT4704(4)+MTT4703(5) MTP4151(1)+STP4752(1)+MTP4152(1) [20]		MMT204 Fluid Dynamics(4) [4]		400	40	PG Diploma after exit from 1st Year (Entry & Exit Option)	
	II		MTT4204(3)+MTP4253(Lab) (1)+MMT106 Complex Analysis(4) & (OE) MMT107/MMT108(4) [1]	MMT105 ODE, PDE(4) [4]		500			
Studetns who exit at the end of 1st year shall be awarded a Postgraduate Diploma									
2	III	MTT5301Abstract(5)+MTT5302Functional Analysis(5) [10]	*MTT5303-(3)Graph Theory and its Applications [3]	MTT5310 RM&IPR-1(1) [1]	Dissertation I-1(6)MTR5352 [6] (RBL-1)	500	40	2nd Year (3rd & 4th Semester)	2 Year PG degree by CW + RW
	IV	MTT5408Operation Research and Industrial Applications-(5)+MTP5459(Lab)(1) [6]			Dissertation II-1(14) [14] MTR5455(RBL-2)				
2	III	MTT5301 Abstract(5)+MTT5302 Functional Analysis(5) [10]	MTT5304-'Number Theory with Cryptography [5]	MTP5358 Python Programming Lab(2)+ RM&IPR-1(1) [3]	MTR5353Dissertation I-1(2) [2] (RBL-1)	500	40	2nd Year (3rd & 4th Semester)	2 Year PG degree by CW
	IV	MTT5409Advanced Graph Theory and Information Security(5)+ MTP5460 lab(1) +MTT5407Measure Theory(5) [11]	Th-1(6) or MTT5408Operation Research and Industrial Applications(5)+MTP5459Lab(1) [6]		MTR5456Dissertation II-1(3) [3] (RBL-2)				
2	III		*MTT5305Linear Programming(3) [3]	MTT5310RM&IPR-1(1) [1]	MTR5354Dissertation I-1(16) [16] (RBL-1)	-	40	2nd Year (3rd & 4th Semester)	2 Year PG degree by RW * Research Based
	IV		*MTT5303Graph Theory and its Applications(3) + MTP5460 lab(1) [4]		MTR5457Dissertation II-1(16) [16] (RBL-2)				

*Courses shall be Research based / Lab based Training / Hands on Training Evaluation will be made as per Rubrics made by the Department/School and duly approved by the Dean Academic Affairs / Committee constituted for the purpose.

No. of Courses | No. of Credits | Total Credits in Block

1.3.5 Programme Outcome (PO's)Vs Courses Mapping Table:

1.3.5.1 COURSE ARTICULATION MATRIX

CO's	PO 1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
MTT-4102	3	2	2	3	2	3	3	2	2
MMT-102	3	2	2	3	3	3	2	2	2
STT-4704	3	2	2	3	2	3	3	2	2
MMT-105	3	2	2	3	2	3	3	2	2
MTT-4703	3	2	2	3	2	3	3	2	2
MTP-4151	3	3	2	3	3	3	3	3	3
STP-4752	3	3	2	3	3	3	3	3	3
MTP-4152	2	3	2	3	3	2	3	3	3
MTT-4204	3	2	2	3	2	3	3	2	2
MMT-106	3	2	3	3	2	3	3	2	2
MMT-107	3	2	2	3	2	3	3	2	2
MMT-108	3	2	3	3	3	3	3	2	2
CCP-4001	3	2	2	3	2	3	3	2	2

MTP-4253	3	3	2	2	3	3	3	3	3
MTR-4854	3	2	3	3	2	3	3	2	3
MMT-154	3	2	3	3	2	3	3	2	3
MTT-5301	3	2	2	3	3	3	2	2	2
MTT-5302	3	2	2	3	2	3	3	2	2
MMT-209	3	3	3	3	2	3	2	2	2
MTT-5303	3	2	2	3	3	3	3	2	2
MTT-5408	3	2	2	3	2	3	2	2	2
MTT-5409	3	2	2	3	2	3	2	2	2
MTT-5310	3	2	2	3	2	3	2	2	2
MTT-5304	3	2	2	3	2	3	2	2	2
MTP-5358	3	3	2	2	3	3	3	2	3
MTT-5407	3	2	2	3	2	3	2	2	2
MTP-5460	3	3	2	2	3	3	3	2	3
MTT-5305	3	2	2	3	2	3	2	2	2
MTP-5459	3	3	2	3	2	3	2	3	3
MTR-5352	3	2	3	3	2	3	3	2	3
MTR-5353	3	3	2	2	3	3	3	2	3
MTP-5354	2	3	2	2	3	3	3	3	2
MTT-5304	3	2	2	3	3	3	3	2	2

MTR-5455	3	3	2	3	2	3	3	2	2
MTR-5456	3	3	2	3	2	3	3	3	2
MTR-5457	3	3	2	2	3	3	3	3	3

1-Slight (Low)
2-Moderate (Medium)
3-Substantial (High)

Department of Mathematics & Data Science
Sharda School of Engineering & Science
M. Sc. (Mathematics)
Batch: 2025-27
TERM: 2501 (Semester-I)

2-Year PG Programme(After 3-Year UG Programme)

S. No.	SUBJECT CODE	Title of Paper	Teaching Load				CREDITS	PRE-REQUISITE/CO-REQUISITE	Type of Course1: 1. CC 2. AECC 3. SEC 4. DSE
	THEORY								
			L	**T**	**P**	**TOTAL**			
1.	MTT4102	REAL ANALYSIS	5	0	0	5	5	**CO-REQUISITE**	CC
2.	MMT 102	LINEAR ALGEBRA	4	0	0	4	4	**CO-REQUISITE**	CC
3.	MTT4703	INTRODUCTION to MATLAB AND ITS APPLICATIONS	4	0	0	4	4		CC
4.	STT4704	PROBABILITY & STATISTICAL METHODS	4	0	0	4	4	**CO-REQUISITE**	CC
	PRACTICALS								
5.	MTP4151	MATHEMATICS LAB- I	0	0	2	2	1	**CO-REQUISITE**	CC
6.	STP4752	STATISTICAL METHODS LAB	0	0	2	2	1	**CO-REQUISITE**	CC
7.	MTP4152	MATHEMATICS LAB- II	0	0	2	2	1	**CO-REQUISITE**	CC
8.	CCP4001	COMMUNITY CONNECT COURSE	0	0	4	4	0		SEC
TOTAL							**20**		

[1] CC: Core Course, AECC: Ability Enhancement Compulsory Courses, SEC: Skill Enhancement Courses, DSE: Discipline Specific Courses

Department of Mathematics & Data Science
Sharda School of Engineering & Science
M. Sc. (Mathematics)
Batch: 2025-27
TERM: 2502 (Semester-II)

S. No.	SUBJECT CODE	Title of Paper	Teaching Load				CREDITS	PRE-REQUISITE/CO-REQUISITE	Type of Course2: 1. CC 2. AECC 3. SEC 4. DSE
	THEORY								
			L	**T**	**P**	**TOTAL**			
1.	MTT4204	NUMERICAL ANALYSIS	3	0	0	3	3	**CO-REQUISITE**	DSE
2.	MMT 106	COMPLEX ANALYSIS	4	0	0	4	4	**CO-REQUISITE**	DSE
3.	MMT107 MMT108 MMT204	TOPOLOGY(OE) DIFFERENTIAL GEOMETRY & TENSOR ANALYSIS FLUID DYNAMICS	0	0	0	4	4	**CO-REQUISITE**	DSE
4.	MMT 105	ORDINARY & PARTIAL DIFFERENTIAL EQUATIONS	4	0	0	4	4	**CO-REQUISITE**	SEC
	PRACTICALS								
5.	MTP4253	NUMERICAL ANALYSIS LAB	0	0	2	2	1	**CO-REQUISITE**	DSE
6.	MTR4854	Project	0	0	8	4	4		Project
TOTAL							**20**		

[2] CC: Core Course, AECC: Ability Enhancement Compulsory Courses, SEC: Skill Enhancement Courses, DSE: Discipline Specific Courses

Department of Mathematics & Data Science
Sharda School of Engineering & Science
M. Sc. (Mathematics)
Batch: 2025-27
TERM: 2601 (Semester-III)

(2 Year PG degree by CW+RW)

S. No.	SUBJECT CODE	Title of Paper	Teaching Load				CREDITS	PRE-REQUISITE/CO-REQUISITE	Type of Course[3]: 1. CC 2. AECC 3. SEC 4. DSE
	THEORY		**L**	**T**	**P**	**TOTAL**			
1.	MTT5301	ABSTRACT ALGEBRA	5	0	0	5	5	**CO-REQUISITE**	CC
2.	MTT5302	FUNCTIONAL ANALYSIS	5	0	0	5	5	**CO-REQUISITE**	CC
3.	MTT5303	Graph Theory and its applications	3	0	0	3	3	**CO-REQUISITE**	DSE
4.	MTT5310	RM & IPR	1	0	0	1	1	**CO-REQUISITE**	SEC
	DISSERTATION								
5.	MTR5352	**DISSERTATION-I**	0	0	12	12	6	**CO-REQUISITE**	Project
TOTAL							**20**		

[3] CC: Core Course, AECC: Ability Enhancement Compulsory Courses, SEC: Skill Enhancement Courses, DSE: Discipline Specific Courses

Department of Mathematics & Data Science
Sharda School of Engineering & Science
M. Sc. (Mathematics)
Batch: 2025-27
TERM: 2602 (Semester-IV)

(2 Year PG degree by CW+RW)

S. No.	SUBJECT CODE	Title of Paper	HOURS				CREDITS	PRE-REQUISITE/CO-REQUISITE	Type of Course4: 1. CC 2. AECC 3. SEC 4. DSE
	THEORY								
			L	**T**	**P**	**TOTAL**			
1.	MTT5408	Operation Research and Industrial Applications	5	0	0	5	5	**CO-REQUISITE**	CC
	PRACTICAL								
2.	MTP5459	Operation Research Lab	0	0	2	1	1	**CO-REQUISITE**	CC
	DISSERTATION								
3.	MTR5455	**DISSERTATION-2**	0	0	28	28	14	**CO-REQUISITE**	Project
TOTAL							**20**		

[4] CC: Core Course, AECC: Ability Enhancement Compulsory Courses, SEC: Skill Enhancement Courses, DSE: Discipline Specific Courses

Department of Mathematics & Data Science
Sharda School of Engineering & Science
M. Sc. (Mathematics)
Batch: 2025-27
TERM: 2601 (Semester-III)

(2 Year PG degree by CW)

S. No.	SUBJECT CODE	Title of Paper	Teaching Load				CREDITS	PRE-REQUISITE/CO-REQUISITE	Type of Course[5]: 1. CC 2. AECC 3. SEC 4. DSE
	THEORY		**L**	**T**	**P**	**TOTAL**			
1.	MTT5301	ABSTRACT ALGEBRA	5	0	0	5	5	**CO-REQUISITE**	CC
2.	MTT5302	FUNCTIONAL ANALYSIS	5	0	0	5	5	**CO-REQUISITE**	CC
3.	MTT5304	Number Theory with Cryptography	5	0	0	5	5		DSE
4.	MTT5310	RM & IPR	1	0	0	1	1		SEC
	PRACTICAL								
5.	MTP5358	Python Programming Lab	0	0	4	4	2		SEC
	DISSERTATION								
6.	MTR5353	**DISSERTATION-I**	0	0	4	4	2		RBL-1
TOTAL							**20**		

[5] CC: Core Course, AECC: Ability Enhancement Compulsory Courses, SEC: Skill Enhancement Courses, DSE: Discipline Specific Courses

Department of Mathematics & Data Science
Sharda School of Engineering & Science
M. Sc. (Mathematics)
Batch: 2025-27
TERM: 2602 (Semester-IV)
(2 Year PG degree by CW)

S. No.	SUBJECT CODE	Title of Paper	HOURS				CREDITS	PRE-REQUISITE/CO-REQUISITE	Type of Course6: 1. CC 2. AECC 3. SEC 4. DSE
	THEORY								
			L	**T**	**P**	**TOTAL**			
1.	MTT5409	Advance Graph Theory and Information Security	**5**	**0**	**0**	**5**	5		CC
2.	MTT5407	Measure Theory	**5**	**0**	**0**	**5**	5		CC
3.	MTT5408	Operation Research and Industrial Applications	5	0	0	5	5	**CO-REQUISITE**	DSE
	PRACTICAL								
4.	MTP5460	Graph Theory Lab	0	0	2	2	1		CC
5.	MTP5459	Operation Research Lab	0	0	2	2	1	**CO-REQUISITE**	DSE
	DISSERTATION								
6.	MTR5456	**DISSERTATION-2**	0	0	6	6	3	**CO-REQUISITE**	RBL-2
TOTAL							**20**		

[6] CC: Core Course, AECC: Ability Enhancement Compulsory Courses, SEC: Skill Enhancement Courses, DSE: Discipline Specific Courses

Department of Mathematics & Data Science
Sharda School of Engineering & Science
M. Sc. (Mathematics)
Batch: 2025-27
TERM: 2601 (Semester-III)

(2 Year PG degree by RW)

S. No.	SUBJECT CODE	Title of Paper	Teaching Load				CREDITS	PRE-REQUISITE/CO-REQUISITE	Type of Course[7]: 1. CC 2. AECC 3. SEC 4. DSE
	THEORY		**L**	**T**	**P**	**TOTAL**			
1.	MTT5305	Linear Programming	3	0	0	3	3	**CO-REQUISITE**	DSE
2.	MTT5310	RM & IPR	1	0	0	1	1		SEC
	DISSERTATION								
3.	MTR5354	**DISSERTATION-I**	0	0	32	32	16		RBL-1
TOTAL							**20**		

[7] CC: Core Course, AECC: Ability Enhancement Compulsory Courses, SEC: Skill Enhancement Courses, DSE: Discipline Specific Courses

Department of Mathematics & Data Science
Sharda School of Engineering & Science
M. Sc. (Mathematics)
Batch: 2025-27
TERM: 2602 (Semester-IV)

(2 Year PG degree by RW)

S. No.	SUBJECT CODE	Title of Paper	Teaching Load				CREDITS	PRE-REQUISITE/CO-REQUISITE	Type of Course[8]: 1. CC 2. AECC 3. SEC 4. DSE
	THEORY		**L**	**T**	**P**	**TOTAL**			
1.	MTT5303	Graph Theory and its applications	3	0	0	3	3	**CO-REQUISITE**	DSE
	PRACTICAL								
2.	MTP5460	Graph Theory Lab	0	0	2	2	1		DSE
	DISSERTATION								
3.	MTR5457	**DISSERTATION-II**	0	0	32	32	16		RBL-2
TOTAL							**20**		

[8] CC: Core Course, AECC: Ability Enhancement Compulsory Courses, SEC: Skill Enhancement Courses, DSE: Discipline Specific Courses

COURSE STRUCTURE

Real Analysis (MTT4102)

School: SSES		**Batch: 2025-27**	
Programme: M.Sc.		**Academic Year: 2025-26**	
Branch: Mathematics		**Semester: I**	
1	Course Code	MTT4102	
2	Course Title	**Real Analysis**	
3	Credits	5	
4	Contact Hours (L-T-P)	5-0-0	
	Course Status	Compulsory	
5	Course Objective	1. The objective of this course is to develop the knowledge of various concepts of Real numbers and their properties. 2. The objective of this course is to develop a deeper and more rigorous understanding of Calculus including defining terms and proving theorems about sequences, series, limits, continuity, derivatives, the Riemann integrals, and sequences of functions.	
6	Course Outcomes	CO1: Explain functions between sets; equivalent sets; finite, countable and uncountable sets and some operations on real numbers. (K2,K4) CO2: Evaluate convergent, divergent, bounded, Cauchy and monotone sequences and series. (K2,K5) CO3: Explain and determine the continuity, discontinuity and uniform continuity of functions. (K2,K3,K4) CO4: Determine the uniform convergence of sequences and series. (K2,K3) CO5: Evaluate convergence and divergence of sequences and series of functions. (K2,K5) CO6: Describe and use the concepts of fundamental theorem of Integral calculus, Riemann Integral and Riemann – Stieltjes integral (K2,K3)	
7	Course Description	This course is an introduction to the fundamentals of Real analysis. This provides the understanding of convergence, divergence, uniform convergence and absolute convergence of sequences and series of Real numbers. It gives an idea about continuity, discontinuity and uniform continuity of functions. It will be helpful in solving Real integrals.	
8	Outline syllabus	Real analysis	CO Mapping
	Unit 1		
	A	Neighbourhoods of a point in Υ, open and closed intervals in Υ, neighbourhoods of points in Υ^2	CO1
	B	limit points of sets, compact sets of R	CO1
	C	Bolzano-Weierstrass theorem, Heine-Borel theorem	CO1
	Unit 2		
	A	Sequence of real numbers, convergence of sequences	CO2
	B	Cauchy sequence, limit superior and limit inferior of sequences	CO2
	C	Series – convergence, tests of convergence, conditional and absolute convergence	CO2

	Unit 3				
	A	Definitions and results based on Continuous functions,uniform continuity absolute continuity,			CO3
	B	uniform convergence of sequences and series			CO4
	C	Term by term differentiation, power series			CO4
	Unit 4				
	A	Study of sequences and series of functions, including pointwise and uniform convergence, the Cauchy criterion for uniform convergence, and tests for convergence such as the			CO5
	B	Weierstrass M-test, Abel's test, and Dirichlet's test. Exploration of the relationship between uniform convergence and operations like differentiation and integration. Discussion of the Weierstrass Approximation Theorem,			CO5
	C	power series and their properties, including the uniqueness theorem, radius and interval of convergence. Additional topics include Abel's and Taylor's theorems, rearrangement of series terms, and Riemann's theorem on conditionally convergent series.			CO5
	Unit 5				
	A	An overview of the Fundamental Theorem of Integral Calculus, the definition of the Riemann integral, refinement of partitions, and Darboux's sums;			CO6
	B	key properties and theorems related to the Riemann integral;			CO6
	C	integration of vector-valued functions; the concept of the Riemann–Stieltjes integral, including partition refinement, its properties and important theorems; and the reduction of the Riemann–Stieltjes integral to the standard Riemann integral.			CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		25%	25%	50%	
	Text book/s*	1. Jain P. K. and Gupta V. P.: Lebesgue measure and integration, Wiley Eastern Ltd., New Age Int. Ltd., New Delhi, (1994). 2. Rudin W.: Principles of Mathematical Analysis			
	Other References	(i) Malik S. C. and SavitaArora; Mathematical Analysis, second ed., Wiley Eastern Ltd., New Age Int. Ltd., New Delhi, (1994). (ii) Somasundaram D. and Chaudhary B.: A first course of Mathematical Analysis, Narosa publishing house, New Delhi, 1987.			

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
MTT4102.1	3	3	3	3	3	3	3	2	1
MTT4102.2	3	2	3	3	2	3	2	1	1
MTT4102.3	2	2	2	2	2	2	2	1	1
MTT4102.4	2	2	1	2	2	2	3	1	1
MTT4102.5	3	2	2	3	2	3	2	2	2
MTT4102.6	3	2	1	3	2	2	2	1	2

School: SSES		**Batch: 2025-27**	
Programme: M.Sc.		**Academic Year: 2025-26**	
Branch: Mathematics		**Semester: I**	
1	Course Code	MMT102	
2	Course Title	LINEAR ALGEBRA	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
	Course Status	Compulsory	
5	Course Objective	1. To familiarise students with basic concept of determinants, properties of determinants, rank of a matrix, inverse of a non-singular square Matrix, solution of system of linear equations. Have an idea of the fields and vector spaces, linear transformations, null spaces, rank and nullity theorem, inner products and norms, orthogonal vectors, Cauchy-Schwarz inequality, Orthogonal bases, Gram - Schmidt process. 2. Have an understanding of Characteristic roots of real matrices, right and left characteristic vectors, independence of characteristic vectors corresponding to distinct characteristic roots. To know definiteness of a real quadratic form, simultaneous reduction of two quadratic forms, maxima and minima of ratio of two quadratic forms.	
6	Course Outcomes	CO1: Describe the basic concept of determinants, properties of determinants, and solve rank of a matrix, inverse of a non-singular square matrix and evaluate solution of system of linear equations. (K1,K2,K3,K5) CO2: Describe the concept of fields and vector spaces, linear transformations, null spaces, explain rank and nullity theorem. (K1,K2, K4) CO3: Explain the concept of inner products and norms, orthogonal vectors, Cauchy-Schwarz inequality and evaluate orthogonal bases, define Gram - Schmidt process. (K1, K2, K4, K5) CO4: Explain characteristic roots of real matrices, right and left characteristic vectors and evaluate independence of characteristic vectors corresponding to distinct characteristic roots. (K2, K4, K5) CO5: Illustrate generalized inverse of a matrix, left inverse, right inverse and pseudo inverse and compose Spectral decomposition theorem. (K3, K6) CO6: Explain Definiteness of a real quadratic form, simultaneous reduction of two quadratic forms and evaluate maxima and minima of ratio of two quadratic forms. (K2, K4, K5)	
7	Course Description	This course is an introduction to Linear Algebra. The primary objective of the course is to develop the advance understanding of linear algebra.	
8	**Outline syllabus LINEAR ALGEBRA**		**CO Mapping**
	Unit 1	**Review of Matrix Algebra**	
	A	Determinants, properties of determinants	CO1
	B	rank of a matrix, inverse of a non-singular square Matrix	CO1

	C	Solution of system of linear equations.			CO1
	Unit 2	**Vector Spaces**			
	A	Fields and vector spaces, linear transformations, null spaces, rank and nullity theorem,			CO2,
	B	Inner products and norms, orthogonal vectors, Cauchy-Schwarz inequality,			CO2, CO3
	C	Orthogonal bases, Gram - Schmidt process			CO2, CO3
	Unit 3	**Characteristic roots and Characteristic Vectors**			
	A	Characteristic roots of real matrices			CO4
	B	Right and left characteristic vectors,			CO4
	C	Independence of characteristic vectors corresponding to distinct characteristic roots			CO4
	Unit 4	**Generalized Inverse**			
	A	Generalized inverse of a matrix			CO5
	B	Left inverse, right inverse and pseudo inverse			CO5
	C	Applications, Spectral decomposition theorem.			CO5
	Unit 5	**Quadratic Forms**			
	A	Definiteness of a real quadratic form			CO6
	B	Simultaneous reduction of two quadratic forms,			CO6
	C	Maxima and minima of ratio of two quadratic forms.			CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		25%	25%	50%	
	Text book/s*	1. Graybill F.A.: Matrix with applications in statistics, 2nd Ed., Wadsworth (1983). 2. Rao C. R. &Mitra S. K. : Generalized inverse of matrices and its application. John Wiley & Sons Inc. (1971)			
	Other References	3. Kenneth Hoffman & Ray Kunze: Linear Algebra, EEE, PHI learning (Indian Ed.), 2012. 4. Hohn F. E.: Elements of Matrix Algebra, Macmillan, (1973). 5. Searle S. R.: Matrix Algebra useful to statistics, John willey& sons 1982.			

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
MMT102.1	3	3	3	3	3	3	3	2	1
MMT102.2	3	2	3	3	2	3	2	1	2
MMT102.3	2	2	2	2	2	2	2	2	1
MMT102.4	2	2	1	2	2	2	3	1	2
MMT102.5	3	2	2	3	2	3	2	2	1
MMT102.6	3	2	1	3	3	2	2	1	1

INTRODUCTION TO MATLAB AND ITS APPLICATIONS (MTT4703)

School: SSES		**Batch: 2025-27**	
Programme: M.Sc.		**Academic Year: 2025-26**	
Branch: Mathematics		**Semester: I**	
1	Course Code	MTT4703	
2	**Course Title**	**INTRODUCTION TO MATLAB AND ITS APPLICATIONS**	
3	Credits	**4**	
4	Contact Hours (L-T-P)	4-0-0	
	Course Status	Compulsory	
5	Course Objective	The goal of this course is to introduce the necessary mathematical concepts for MATLAB and cover the syntax and semantics of MATLAB including control structures, comments, variables, functions etc. Once the foundations of the language have been established students will explore different types of scientific Programmeming problems including curve fitting, ODE solving etc.	
6	Course Outcomes	CO1: Describe the fundamentals of MATLAB and use MATLAB for interactive computations. (K2, K3) CO2: Demonstrate with strings and matrices and their uses. (K2, K3) CO3: Illustrate basic flow controls (if-else, for, while). (K3) CO4: Create plots and export this for use in reports and presentations. (K3, K5) CO5: Develop Programme scripts and functions using the MATLAB development environment. (K4, K5) CO6: Write the Programme for evaluates linear system of equations, ordinary differential equations in MATLAB. (K5,K6)	
7	Course Description	The course will give the fundamental knowledge and practical abilities in MATLAB required to effectively utilize this tool in technical numerical computations and visualisation in other courses. Syntax and interactive computations, Programming in MATLAB using scripts and functions, rudimentary algebra and analysis. One- and two-dimensional graphical presentations. Examples on engineering applications.	
8	Outline syllabus	**Introduction to MATLAB**	CO Mapping
	Unit 1	**Introduction**	
	A	Vector and matrix generation, Subscripting and the colon notation.	CO1
	B	Matrix and array operations and their manipulations,	CO1
	C	Introduction to some inbuilt functions.	CO1
	Unit 2	**Relational and Logical Operators**	
	A	Using conditional operators and flow control using various statement and loops including If-End statement, If-Else –End statement	CO1, CO3
	B	Nested If-Else-End Statement,	CO3
	C	For – End and While-End loops with break commands.	CO3
	Unit 3	**m-files**	

	A	Overview of scripts and functions in MATLAB, the concepts of local and global variables,			CO2,CO5
	B	examples of commonly used built-in functions, and how to edit and save .m files.			CO2,CO5
	C	Recreate the logic behind some built-in functions through custom code.			CO2,CO5
	Unit 4	**Two dimensional Graphics**			
	A	Create basic plots in MATLAB, modifying axes and adding annotations,			CO4
	B	displaying multiple plots within a single figure,			CO4
	C	saving and printing figures, and working with subplots in multiple dimensions.			CO4
	Unit 5	**Applications of MATLAB**			
	A	Solving linear systems of equations, performing polynomial curve fitting using built-in functions like polyfit,			CO5, CO6
	B	solving single-variable and two-variable equations, and			CO5, CO6
	C	using built-in functions to solve ordinary differential equations.			CO5, CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		25%	25%	50%	
	Text book	An introduction to MATLAB : Amos Gilat			
	Other References	1. Applied Numerical Methods with Matlab for engineering and Scientists by stevenchapra, Mcgraw Hill. 2. Getting started with Matlab: RudraPratap			

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
MTT4703.1	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**1**
MTT4703.2	**3**	**2**	**3**	**3**	**2**	**3**	**2**	**1**	**2**
MTT4703.3	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**1**	**1**
MTT4703.4	**2**	**2**	**1**	**2**	**2**	**2**	**3**	**1**	**1**
MTT4703.5	**3**	**2**	**2**	**3**	**2**	**3**	**2**	**2**	**2**
MTT4703.6	**3**	**2**	**1**	**3**	**2**	**2**	**2**	**1**	**2**

School: SSES		**Batch: 2025-27**
Programme: M. Sc.		**Academic Year: 2025-26**
Branch: Mathematics		**Semester: I**
1	Course Code.	STT4704
2	Course Title	Probability & Statistical Methods
3	Credits	4
4	Contact Hours (L-T-P)	4-0-0
	Course status	Compulsory
5	Course Objectives	This course aims to develop a strong foundation in descriptive statistics, probability theory, and statistical inference. Students will learn key concepts such as probability spaces, random variables, probability functions, generating functions, and hypothesis testing. The course also covers laws of large numbers, probability inequalities, and central limit theorems, equipping students with essential tools for data analysis and statistical modeling.
6	Course Outcomes	CO1: Understand and analyze descriptive statistics, measures of central tendency, dispersion, and fundamental set theory concepts. (K1, K2, K6) CO2: Grasp fundamental probability concepts, including probability spaces, independence, conditional probability, and Bayes' theorem. (K1,K2,K4) CO3:Explore random variables, probability functions, mathematical expectations, and probability inequalities. (K2,K3,K4) CO4: Analyze bivariate distributions, marginal and conditional distributions, and their statistical implications. (K2,K4) CO5: Understand generating functions, hypothesis testing, and statistical inference concepts, including Type I & II errors. (K1,K2, K5) CO6: Apply laws of large numbers, central limit theorems, and statistical inequalities in probability and inference.. (K2,K3,K4)
7	Course Description	This course covers descriptive statistics, probability theory, random variables, probability distributions, generating functions, and hypothesis testing. It also explores laws of large numbers, probability inequalities, and central limit theorems for statistical analysis and decision-making.
8	Outline syllabus:	

UNIT1	Descriptive Statistics and Probability	CO Mapping
A	Representation of data (measures of central tendency).	CO1
B	Dispersion & other characteristics of data (mean deviation, variance, quartiles, Skewness and Kurtosis, Moments).	CO1
C	Classes of Sets, Fields, sigma-fields, minimal sigma-field, Borel field	CO1
UNIT 2	Probability: Basic Concepts and Conditional Probability	
A	Probability space, Basic terminologies and theorems on probability, theorem of total probability, theorems on compound probability	CO2
B	Independence of events, conditional probability	CO2

C	Bayes' Theorem and its applications	CO2

UNIT 3	Random Variables and Probability Functions			
A	Random Variable and its properties, mathematical expectation and inequalities involving random variables viz. Markov's, Holder's, Minkowski's and Jenson's Inequalities			CO3
B	PDF, PMF, Distribution function			CO3
C	Bivariate random variables, Marginal and conditional distributions			CO3, CO4
UNIT 4	Generating Functions and Hypothesis			
A	Generating functions, probability generating function, moment generating function characteristic functions,			CO3, CO5
B	factorial moment generating functions, Uniqueness theorem.			CO5, CO6
C	Hypothesis testing, Type I and II error, Level of Significance, power of test, large and small sample test.			CO5, CO6
UNIT 5	The Laws of Large Numbers, Inequalities and Central limit Theorem			
A	Law of large numbers, Chebyshev's and Khinchin's weak law of large numbers, Kolmogorov's theorem, Strong law of large numbers.			CO5, CO6
B	Central limit theorem, De-Moivre's Laplace central limit theorem.			CO5, CO6
C	Statement of Lindeberg- Feller's central limit theorem.			CO5, CO6
	Mode of Examination	Theory		
	Weightage distribution	CA	MTE	ETE
		25%	25%	50%
	Text books	1. Gupta,S.C and Kapoor,V.K, "Fundamental of Mathematical Statistics". Sultan Chand & sons.		
	Other references	1.Ash, Robert B. (2000). Probability and Measure Theory, Second Edition, Academic Press, New York. 2. Feller, W. (1985). Introduction to Probability Theory and its Applications, Wiley Eastern, New Delhi 3. Bhatt, B.R. (1999). Modern Probability Theory, 3rd Edition, New Age International Publishers. 4. A. K. Md. Ehsanes Saleh and Vijay K. Rohatgi (2010) An Introduction to Probability and Statistics, Wiley India Pvt. Ltd.		

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
STT4704.1	3	3	3	3	3	3	3	2	1
STT4704.2	3	2	3	3	2	3	2	1	2
STT4704.3	2	2	2	2	2	2	2	2	1
STT4704.4	2	2	1	2	2	2	3	1	1
STT4704.5	3	2	2	3	2	3	2	2	2
STT4704.6	3	2	1	3	2	2	2	1	2

School: SSES		**Batch: 2025-27**	
Programme: M.Sc.		**Academic Year: 2025-26**	
Branch: Mathematics		**Semester: I**	
1	Course Code	MTP4151	
2	Course Title	Mathematics Lab I	
3	Credits	1	
4	Contact Hours (L-T-P)	0-0-2	
	Course Status	Compulsory	
5	Course Objective	The goal of this course is to introduce students to the fundamental mathematical concepts for MATLAB. The course will cover the syntax and semantics of MATLAB including control structures, comments, variables, functions etc. Once the foundations of the language have been established students will explore different types of scientific Programmeming problems including curve fitting, ODE solving etc	
6	Course Outcomes	CO1: Describe the fundamentals of MATLAB and use MATLAB for interactive computations. (K2, K3) CO2: Demonstrate with strings and matrices and their uses. (K2, K3) CO3: Illustrate basic flow controls (if-else, for, while). (K3) CO4: Create plots and export this for use in reports and presentations. (K3, K5) CO5: Develop Programme scripts and functions using the MATLAB development environment. (K4, K5) CO6.Create and control simple plot and user-interface graphics objects in MATLAB (K4, K5)	
7	Course Description	The course will give the fundamental knowledge and practical abilities in MATLAB required to effectively utilize this tool in technical numerical computations and visualisation in other courses. Syntax and interactive computations, Programmeming in MATLAB using scripts and functions, rudimentary algebra and analysis. One- and two-dimensional graphical presentations. Examples on engineering applications.	
8	Outline syllabus		CO Mapping
	Unit 1		**CO1**
		Creating code in MATLAB for simple algebra and creating an Array in MATLAB	CO1
	Unit 2	Creating MATLAB code for Mathematical Operations with numbers	**CO3**
	Unit 3	Creating MATLAB code for making scripts files in MATLAB and using it for user friendly inputs.	**CO4**
	Unit 4	Creating MATLAB code for basic three-dimensional, change in axes and annotation in a figure.	**CO5,CO6**
	Unit 5	Creating MATLAB code for--- If-End statement, If-Else-End statement, nested If-Else-End statement	**CO2,CO6**

		.Solving a system of linear equations.			
	Mode of examination	Practical &Viva			
	Weightage Distribution	CA	CE	ETE	
		30%	30%	40%	
	Text book	1. An introduction to MATLAB : Amos Gilat			
	Other References	1. Applied Numerical Methods with Matlab for engineering and Scientists by stevenchapra, Mcgraw Hill. 1. Getting started with Matlab: RudraPratap			

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
MTP4151.1	**3**	**3**	**2**	**2**	**2**	**3**	**2**	**2**	**3**
MTP4151.2	**2**	**3**	**3**	**3**	**3**	**2**	**3**	**3**	**2**
MTP4151.3	**2**	**3**	**2**	**2**	**3**	**3**	**3**	**3**	**3**
MTP4151.4	**2**	**3**	**2**	**3**	**2**	**2**	**2**	**3**	**2**
MTP4151.5	**3**	**3**	**2**	**3**	**2**	**2**	**3**	**2**	**3**
MTP4151.6	**2**	**2**	**3**	**3**	**2**	**2**	**2**	**2**	**3**

STATISTICAL METHODS LAB (STP4752)

School: SSES		**Batch: 2025-27**			
Program: M.Sc.		**Academic Year: 2025-26**			
Branch: Mathematics		**Semester: I**			
1	Course Code	**STP4752**			
2	Course Title	Statistical Methods Lab			
3	Credits	1			
4	Contact Hours (L-T-P)	0-0-2			
	Course Status	Compulsory			
5	Course Objective	To provide hands-on experience in solving statistical and probability-related problems using computational tools and real-life data applications.			
6	Course Outcomes	After the completion of this course, students will be able to: CO1: Demonstrate descriptive statistical measures and probability concepts using computational tools. (K2, K3, K4) CO2: Analyze correlation, regression, and curve fitting techniques. (K4, K5) CO3: Implement regression models and evaluate their effectiveness. (K4, K5) CO4: Perform hypothesis testing using various parametric and non-parametric tests. (K3, K4) CO5: Apply design of experiments in statistical data analysis. (K4, K5) CO6: Utilize measure theory concepts in probability and statistical applications. (K5, K6)			
7	Course Description	This practical course reinforces the theoretical foundations of descriptive statistics, probability, correlation, regression, hypothesis testing, design of experiments, and measure theory through computational simulations and data analysis. Students will use programming tools such as R or Python to implement statistical models and conduct real-world data-driven analysis.			
8	Outline syllabus				CO Mapping
	Unit 1	**Descriptive Statistics and Probability**			
		Problem Based on Descriptive Statistics and Probability using R or Python			CO1
	Unit 2	**Correlation, Regression, and Curve Fitting**			
		Problem Based on correlation, regression and curve fitting using R or Python			CO2, CO3
	Unit 3	**Testing of Hypothesis**			
		Problem based on testing of Hypothesis using R or Python			CO4
	Unit 4	**Design of Experiments**			
		Problem based on ANOVA using R or Python			CO5
	Unit 5	**CLT and Law of large number**			
		Problem based on Central limit theorem and Laws of large number using R or Python			CO6
	Mode of examination	Practical/CE			
	Weightage Distribution	CA	CE	ESE	
		30%	30%	40%	

	Text book/s*	• Introduction to Probability and Statistics by S.C. Gupta & V.K. Kapoor • Probability and Statistical Inference by Robert V. Hogg & Elliot A. Tanis	
	Other References	• Introduction to Probability Models by Sheldon M. Ross • Computational Probability and Statistics using R/Python (Online Resources)	

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
STP4752.1	**1**	**3**	**1**	**1**	**2**	**1**	**2**	**1**	**2**
STP4752.2	**1**	**3**	**1**	**1**	**2**	**1**	**2**	**1**	**2**
STP4752.3	**1**	**3**	**1**	**1**	**2**	**1**	**2**	**1**	**2**
STP4752.4	**1**	**3**	**1**	**1**	**2**	**1**	**2**	**1**	**2**
STP4752.5	**1**	**3**	**1**	**1**	**2**	**1**	**2**	**1**	**2**
STP4752.6	**1**	**3**	**1**	**1**	**2**	**1**	**2**	**1**	**2**

School: SSES		**Batch: 2025- 27**	
Programme:M.Sc		**Academic Year: 2025-26**	
Branch: Mathematics		**Semester: I**	
1	Course Code	MTP4152	
2	Course Title	Mathematics Lab II	
3	Credits	1	
4	Contact Hours (L-T-P)	0-0-2	
	Course Status	Compulsory	
5	Course Objective	To create understanding of the LaTeX and enable the students how to write resume, write question paper, write articles/ research papers.	
6	Course Outcomes	CO1: Understand the procedures,Analyzing and Visualizing Data with Excel. (K2) CO2: Discuss and develop the basic understanding of creating formulas and how cells are referenced by rows and columns within Excel. (K2, K5, K6) CO3: Discuss and construct table and graph of data with excel. (K2, K5, K6) CO4: Discuss and calculate basic statistical parameters (mean, measures of dispersion, correlation coefficient, indexes). (K2, K5, K6) CO5: Discuss and calculate correlationbetween two variables with excel. (K2, K5, K6) CO6: Discuss, predict and estimate the variable by regression analysis with excel. (K2, K5, K6)	
7	Course Description	This course teaches the LaTeX to students and describes how to write resume, write question paper, and write articles / research papers.	
8	Outline syllabus		CO Mapping
	Unit 1		
		Practical based on Installation of the software LaTeX Understanding Latex compilation: Basic Syntax, Writing equations,	CO1, CO2
	Unit 2		
		Practical related to --Page Layout – Titles, Abstract Chapters, Sections, References, Equation references, citation. List making environments Table of contents, Generating new commands	CO1, CO3
	Unit 3		
		Packages: Geometry, Hyperref, amsmath, amssymb, algorithms	CO1, CO4
	Unit 4		
		Practical related to--- Classes: article, book, report	CO1,CO5
	Unit 5		
		Applications to: Writing resume	CO1, CO6

		Writing articles/ research papers			
	Mode of examination	Practical			
	Weightage Distribution	CA	CE	ETE	
		30%	30%	40%	
	Text book/s*				
	Other References				

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
MTP4152.1	**3**	**3**	**2**	**2**	**2**	**3**	**2**	**2**	**1**
MTP4152.2	**2**	**3**	**3**	**3**	**3**	**2**	**1**	**2**	**1**
MTP4152.3	**2**	**3**	**2**	**2**	**3**	**2**	**3**	**2**	**2**
MTP4152.4	**2**	**3**	**2**	**3**	**2**	**2**	**2**	**2**	**3**
MTP4152.5	**3**	**3**	**2**	**3**	**2**	**2**	**2**	**2**	**2**
MTP4152.6	**3**	**2**	**2**	**2**	**3**	**2**	**2**	**2**	**3**

COMMUNITY CONNECT(CCP4001)

<table>
<tr><td colspan="2">SCHOOL:
SSES</td><td>TEACHING DEPARTMENT:
Community Connect</td><td>Academic Year:
2025-26</td><td>FOR STUDENTS of M.Sc.
Batch: 2025-27</td></tr>
<tr><td>1</td><td>Course Number</td><td colspan="3">Course Code: CCP4001</td></tr>
<tr><td>2</td><td>Course Title</td><td colspan="3">Community Connect</td></tr>
<tr><td>3</td><td>Credits</td><td colspan="3">0</td></tr>
<tr><td>3.01</td><td>(L-T-P)</td><td colspan="3">(0-0-4)</td></tr>
<tr><td>4</td><td>Learning Hours</td><td colspan="3"><table><tr><td>Contact Hours</td><td>30</td></tr><tr><td>Project/Field Work</td><td>20</td></tr><tr><td>Assessment</td><td>00</td></tr><tr><td>Guided Study</td><td>10</td></tr><tr><td>Total hours</td><td>60</td></tr></table></td></tr>
<tr><td>5</td><td>Course Objectives</td><td colspan="3">1. To expose our students to different social issues faced by the people in different sections of society.
2. To connect their class-room learning with problem solving skills in real life scenario.</td></tr>
<tr><td>6</td><td>Course Outcomes</td><td colspan="3">After completion of this course students will be able to:
CO1. Recognise social problems prevailing in different sections of society and finding the solution in sustainable manner.
CO2. Get practical exposure of all round development which complements their class room learning
CO3. These activities will add value to students, faculty members, school and university.
CO4. Apply their knowledge via research, and training for community benefit.
CO5. Analyze work on socio-economic projects with teamwork and timely delivery.
CO6. Survey will help to identify the gaps and create a plan to further improve the situation related to social problems prevailing in different sections of society and finding the solution in sustainable manner.</td></tr>
<tr><td>7</td><td>Theme</td><td colspan="3">Major themes for research:
1. Survey and self-learning: In this mode, students will make survey, analyse data and will extract results out of it to correlate with their theoretical knowledge. E.g. Crops and animals, land holding, labour problems, medical problems of animals and humans, savage and sanitation situation, waste management etc.</td></tr>
</table>

		2. ***Survey and solution providing***: In this mode, students will identify the common problems and will provide solution/ educate rural population. E.g. air and water pollution, need of after treatment, use of renewable
		(mainly solar) energy, electricity saving devices, inefficiencies in cropping system, animal husbandry, poultry, pest control, irrigation, machining in agriculture etc. 3. Survey and reporting: In this mode students will educate villagers and survey the ground level status of various government schemes meant for rural development. The analysed results will be reported to concerned agencies which will help them for taking necessary/corrective measures. E.g. Pradhan Mantri Jan Dhan Yojana, Pradhan Mantri MUDRA Yojana, Pradhan Mantri Jeevan Jyoti Bima Yojana, Atal pension Yojana, Pradhan Mantri Awas Yojana, Pradhan Mantri FasalBima Yojana, Swachh Bharat Abhiyan, Soil Health Card Scheme, Digital India, Skill India Programme, Beti Bachao, Beti Padhao Yojana, DeenDayal Upadhyaya Gram Jyoti Yojana, Shyama Prasad Mukherjee Rurban Mission, UJWAL Discom Assurance Yojana, PAHAL,Pradhan Mantri Awas Yojana-Gramin, Pradhan Mantri Yuva Yojana, Pradhan Mantri Jan Aushadhi Yojana, Pradhan Mantri KhanijKshetra Kalyan Yojana, Pradhan Mantri Suraksha Bima Yojana, UDAN scheme, DeenDayal Upadhyaya Grameen Kaushalya Yojana, Pradhan Mantri Sukanya Samriddhi Yojana, Sansad Adarsh Gram Yojana, Pradhan Mantri SurakshitMatritva Abhiyan, Pradhan Mantri RojgarProtsahan Yojana, Midday Meal Scheme, Pradhan Mantri Vaya Vandana Yojana, Pradhan Mantri Matritva Vandana Yojana, and Ayushman Bharat Yojana.
8.1	**Guidelines for Faculty Members**	It will be a group assignment. There should be not more than 10 students in each group. The faculty guide will guide the students and approve the project title and help the student in preparing the questionnaire and final report. The questionnaire should be well design and it should carry at least 20 questions (Including demographic questions). The faculty will guide the student to prepare the PPT. The topic of the research should be related to social, economical or environmental issues concerning the common man.

		The report should contain 2,500 to 3,000 words and relevant charts, tables and photographs. The student should submit the report to CCC-Coordinator signed by the faculty guide by 15 April 2019. The students have to send the hard copy of the report and PPT, and then only they will be allowed for ETE.
8.2	**Role of CCC-Coordinator**	The CCC Coordinator will supervise the whole process and assign students to faculty members. 1. PG-M.Sc.-Semester II – the students will be allocated to faculty member (mentors/faculty member) in even term. 2. UG- B.Sc.-Semester III - the students will be allocated to faculty member (mentors/faculty member) in odd term.
8.3	**Layout of the Report**	Abstract(250 words) a. Introduction b. Literature review(optional) c. Objective of the research d. Research Methodology e. Finding and discussion f. Conclusion and recommendation g. References Note: Research report should base on primary data.
8.4	**Guideline for Report Writing**	Title Page: The following elements must be included: • Title of the article; • Name(s) and initial(s) of author(s), preferably with first names spelled out; • Affiliation(s) of author(s); • Name of the faculty guide and Co-guide Abstract: Each article is to be preceded by a succinct abstract, of up to 250 words, that highlights the objectives, methods, results, and conclusions of the paper. Text:Manuscripts should be submitted in Word. • Use a normal, plain font (e.g., 12-point Times Roman) for text.

		• Use italics for emphasis. • Use the automatic page numbering function to number the pages. • Save your file in docx format (Word 2007 or higher) or doc format (older Word versions) Reference list: The list of references should only include works that are cited in the text and that have been published or accepted for publication. The entries in the list should be in alphabetical order. Journal article Hamburger, C.: Quasimonotonicity, regularity and duality for nonlinear systems of partial differential equations. Ann. Mat. Pura Appl. 169, 321–354 (1995) Article by DOI Sajti, C.L., Georgio, S., Khodorkovsky, V., Marine, W.: New nanohybrid materials for biophotonics. Appl. Phys. A (2007). doi:10.1007/s00339-007-4137-z Book Geddes, K.O., Czapor, S.R., Labahn, G.: Algorithms for Computer Algebra. Kluwer, Boston (1992) Book chapter Broy, M.: Software engineering — from auxiliary to key technologies. In: Broy, M., Denert, E. (eds.) Software Pioneers, pp. 10–13. Springer, Heidelberg (2002) Online document Cartwright, J.: Big stars have weather too. IOP Publishing PhysicsWeb. http://physicsweb.org/articles/news/11/6/16/1 (2007). Accessed 26 June 2007
		Always use the standard abbreviation of a journal's name according to the ISSN List of Title Word Abbreviations, see www.issn.org/2-22661-LTWA-online.php For authors using EndNote, Springer provides an output style that supports the formatting of in-text citations and reference list. EndNote style (zip, 2 kB) Tables:All tables are to be numbered using Arabic numerals. Figure Numbering:All figures are to be numbered using Arabic numerals.

		The soft copy of final report should be submitted by email to Dr. PialiHaldar(piali.haldar@sharda.ac.in)within 16**th April2019 along with hard copy signed by faculty guide**.
8.5	**Format:**	The report should be Spiral/ hardbound The Design of the Cover page to report will be given by the Coordinator- CCC Coverpage Acknowledgement Content Project report Appendices

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
CCP4001.1	**2**	**2**	**3**	**3**	**3**	**3**	**3**	**2**	**1**
CCP4001.2	**2**	**2**	**3**	**3**	**2**	**3**	**2**	**1**	**2**
CCP4001.3	**2**	**2**	**3**	**2**	**3**	**2**	**2**	**2**	**1**
CCP4001.4	**2**	**2**	**1**	**2**	**2**	**2**	**3**	**1**	**2**
CCP4001.5	**2**	**2**	**2**	**3**	**2**	**3**	**2**	**2**	**2**
CCP4001.6	**2**	**2**	**1**	**3**	**2**	**2**	**2**	**1**	**2**

School: SSES		**Batch: 2025-27**	
Programme: M.Sc.		**Academic Year: 2025-26**	
Branch: Mathematics		**Semester: II**	
1	Course Code	MTT4204	
2	Course Title	**Numerical Analysis**	
3	Credits	3	
4	Contact Hours (L-T-P)	3-0-0	
	Course Status	CC	
5	Course Objective	• To provide the student with numerical methods of solving the non-linear equations, interpolation, differentiation, and integration. • To improve the student's skills in numerical methods by using the MATLAB	
6	Course Outcomes	CO1: Estimate errors in numerical solution of a given problem. CO2: Find a root of transcendental equation. CO3: Solve a linear system of equations using iterative and factorization methods and discuss its convergence. CO4: Estimate numerical value of differentiation and integration using interpolation. CO5: Solve initial value problems numerically through single-step and multi-step methods. CO6: Apply finite difference technique for the solution of ordinary and partial differential equations.	
7	Course Description	This course is an introduction to the numerical analysis. The primary objective of the course is to develop the basic understanding of numerical algorithms and skills to implement algorithms to solve mathematical problems in MATLAB.	
8	Outline syllabus		CO Mapping
	Unit 1	**Error Analysis and solution of transcendental equations**	
	A	Sources and definitions of errors, sensitivity and conditioning, and their impact on numerical methods. Stability versus accuracy in computations, as well as floating-point arithmetic and rounding errors.	CO1
	B	The Intermediate Value Theorem, along with root-finding methods such as the bisection method, method of false position, secant method, and Newton-Raphson method.	CO1, CO2
	C	Rate of convergence of iterative methods.	CO2
	Unit 2	**Solution of system of linear equations**	
	A	Iterative methods: Jacobi's method, Gauss-Seidal method	CO1, CO3
	B	Convergence criteria of iterative methods	CO3
	C	LU factorization methods: Crout, Choleski and Doolittle	CO3
	Unit 3	**Interpolation, differentiation and integration**	
	A	Finite difference operators, Newton Gregory forward and backward interpolation, Lagrange interpolation and Newton's divided difference interpolation	CO1, CO4
	B	Derivative formulae based on interpolating polynomial, Newton-Cotes quadrature formula	CO4

	C	Trapezoidal rule, Simpson's 1/3rd and 3/8th rules, Gauss quadrature formula.			CO1, CO4
	Unit 4	**Solution of ordinary differential equations**			
	A	Single-step methods: General definitions and the Lipschitz condition. Derivations and stability analysis of the Taylor series method,			CO5
	B	Euler's method, and Runge-Kutta methods (second-order and fourth-order).			CO1, CO5
	C	Solution of boundary value problems using the finite difference technique.			CO1, CO6
	Unit 5	**Solution of Partial Differential Equations**			
	A	Results on finite difference approximations of partial derivatives			CO6
	B	including the standard five-point and diagonal five-point formulas. Solutions to elliptic equations, such as Laplace and Poisson's equations,			CO1, CO6
	C	Solution of parabolic equations like the one-dimensional heat equation. Solution of hyperbolic equations, including the wave equation.			CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		25%	25%	50%	
	Text book/s*	1) M.K. Jain, S.R.K. Iyengar and R.K. Jain, Numerical Methods for Scientific and Engineering Computation, New Age International (P) Ltd., Publishers, 6 ed, 2012. 2) S.S. Sastry, Introductory Methods of Numerical Analysis, PHI Learning Pvt., Ltd., 5 ed, 2018. 3) C. F. Gerald and Patrick O. Wheatley, Applied Numerical Analysis, Pearson Education, 2006.			
	Other References	1) E. Kreyszig, Advanced Engineering Mathematics, Wiley Publications, 10 ed. 2) Steven C. Chapra and Raymond P. Canale, Numerical Methods for Engineers, Tata McGraw Hill Education Pvt., Ltd., 5 ed, 2007.			

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
MTT4204.1	3	3	3	3	3	3	3	2	1
MTT4204.2	3	2	3	3	2	3	2	1	1
MTT4204.3	2	2	2	3	2	2	2	2	2
MTT4204.4	2	2	2	3	2	2	3	1	1
MTT4204.5	3	2	2	3	2	3	2	2	2
MTT4204.6	3	2	1	3	2	2	2	1	2

Complex Analysis(MMT106)

School: SSES		**Batch: 2025-27**
Programme: M.Sc.		**Academic Year: 2025-26**
Branch: Mathematics		**Semester: II**
1	Course Code	MMT106
2	Course Title	Complex Analysis
3	Credits	4
4	Contact Hours (L-T-P)	4-0-0
	Course Status	Compulsory
5	Course Objective	• This course is aimed to provide an introduction to the theories for functions of a complex variable. The concepts of analyticity, Cauchy-Riemann relations and harmonic functions, Complex integration and complex power series are presented. Discuss the classification of isolated singularities and examine the theory and illustrate the applications of the calculus of residues in the evaluation of integrals. • Students will study geometric properties of conformal mappings in the plane and their relations with analytic functions
6	Course Outcomes	CO1: Discuss the concept of complex number and its algebra calculates continuity, differentiability, analyticity of a function and analyse the derivative of a function. (K2,K3, K4) CO2: Describe the concept of analytic function and check the analyticity of the functions. (K3, K6) CO 3: Explain the concept of harmonic function and evaluate harmonic conjugates and discuss about series and their convergence, power series, radius of convergence. (K2, K4,K5) CO 4: Illustrate the concept of complex integration, write the Green's theorem, anti-derivative theorem, Cauchy-Goursat theorem, Cauchy's integral formula, Liouville theorem, Morera's theorem and evaluate derivative of analytic functions. (K3, K5,K6) CO 5: Discuss the concept of singularities and its types; write Taylor and Laurent series, Cauchy's residue theorem, evaluate the definite integrals using Cauchy's residue theorem.(K1,K2,K5,K6) CO6: Demonstrate the understanding of conformal mappings and Construct conformal mappings between many kinds of domain. (K2, K5)
7	Course Description	This course is an introduce the theories for functions of a complex variable. The concepts of analyticity, Cauchy-Riemann relations and harmonic functions, Complex integration and complex power series are presented. Discuss the classification of isolated singularities and examine the theory and illustrate the applications of the calculus of residues in the evaluation of integrals.

8	Outline syllabus				CO Mapping
	Unit 1				
	A	Complex numbers, their representation in Argand's plane and the algebra of complex numbers,			CO1
	B	The complex plane and open set, domain and region in a complex plane			CO1
	C	Complex functions and their limits, continuity, differentiability.			CO1
	Unit 2				
	A	Analytic function, The C-R equations and sufficient conditions for differentiability and analyticity			CO2
	B	Harmonic functions and harmonic conjugates, Sequences,			CO3
	C	Series and their convergence, power series, radius of convergence.			CO3
	Unit 3				
	A	Complex integration: Line integration, path independence,			CO4
	B	Green's theorem, anti-derivative theorem, Cauchy-Goursat theorem, Cauchy's integral formula,			CO4
	C	Derivative of analytic functions, Liouville theorem, Morera's theorem.			CO4
	Unit 4				
	A	Singularities and its types; Taylor and Laurent series			CO5
	B	Cauchy's residue theorem,			CO5
	C	Evaluation of definite integrals using Cauchy's residue theorem.			CO5
	Unit 5				
	A	Transformations or mappings, some standard transformations,			CO6
	B	Bilinear transformation, fixed point of a transformation,			CO6
	C	Conformal transformation, jacobian of a transformation and few special conformal mappings			CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		25%	25%	50%	
	Text book/s*	1) Churchill, Ruel V. and Brown, JamesWard, Complex Variables and Applications, fourth edition, McGraw-Hill Book Co., New York, 1984. 2) Conway, John B., Functions of One Complex Variable, II, Graduate Texts inMathematics, 159, Springer-Verlag, New York, 1995.			

	Other References	1) Schaum's Outline of Complex Variables, 2ed by By Murray Spiegel, Seymour Lipschutz, John Schiller, Dennis Spellman 2) Ahlfors, Lars V., Complex Analysis: An Introduction to the Theory of Analytic Functions of One Complex Variable, third edition. International Series in Pure and Applied Mathematics, McGraw-Hill Book Co., New York, 1978.	

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
MMT106.1	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**1**
MMT106.2	**3**	**2**	**3**	**3**	**2**	**3**	**2**	**1**	**1**
MMT106.3	**2**	**2**	**3**	**2**	**2**	**2**	**3**	**2**	**2**
MMT106.4	**2**	**2**	**2**	**2**	**2**	**2**	**3**	**1**	**1**
MMT106.5	**3**	**2**	**2**	**3**	**2**	**3**	**2**	**2**	**2**
MMT106.6	**3**	**2**	**1**	**3**	**2**	**2**	**2**	**1**	**2**

TOPOLOGY (MMT 107)

School: SSES		**Batch: 2025-27**	
Programme: M.Sc.		**Academic Year: 2025-26**	
Branch: Mathematics		**Semester: II**	
1	Course Code	MMT107	
2	Course Title	TOPOLOGY	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
	Course Status	Compulsory	
5	Course Objective	This course provides an introduction to topics involving concepts of Topological space and separate axioms (Hausdorff space and base problems), Compactness (Urysohn's theorem), Connectedness With Nets(converge filter Zorn's lemma).	
6	Course Outcomes	CO1: Explain the concept of Topological spaces and calculate interior, exterior limit point and boundary points. (K2, K3, K4) CO2: Describe the concept of separate axioms and evaluate T_0, T_1, T_2 spaces, normal and completely normal spaces. (K1,K2, K5) CO3: Discuss the compactness (Urysohn's theorem) and evaluate cover, open cover, finite sub cover, compact sets. (K1, K2, K5) CO4: Explain Lindeloff space, locally compact, Map: continuous function and write Heine borel theorem, describe homeomorphism, open and closed map, compactness for continuous images. (K2,K4,K6) CO5: Explain about separated sets, disconnectedness, totally disconnectedness, maximal connected set and illustrate component and path, locally connected and write Urysohn's theorem. (K2, K3, K4, K6) CO6: Describe the concept of Nets and Filters and write zorn's lemma. (K1,K2, K6)	
7	Course Description	This course provides an introduction to topics involving concepts of Topological space and separate axioms (Hausdorff space and base problems), Compactness (Urysohn's theorem), Connectedness With Nets (converge filter Zorn's lemma). The primary objective of the course is to develop the advance understanding of Topology.	
8	Outline syllabus		CO Mapping
	Unit 1	**Topological space**	
	A	Topology, weaker and stronger topology, indiscrete and discrete topology	CO1
	B	Co-finite and usual topology, interior, exterior	CO1
	C	limit point and boundary points.	CO1
	Unit 2	**Separation axioms**	
	A	Base, sub-base and countability (first countable and second countable)	CO2

	B	separation axioms: T_0, T_1, T_2 spaces, normal and completely normal spaces			CO2
	C	regular and completely regular spaces, T_3, T_4 and Tychnoff space, Hausdorff space and based problems			CO2
	Unit 3	**Compactness**			
	A	Cover, open cover, finite sub cover, compact sets, finite intersection property			CO3
	B	Heine borel theorem, Lindeloff space, locally compact, Map: continuous function			CO3, CO4
	C	homeomorphism, open and closed map, compactness for continuous images			CO3, CO4
	Unit 4	**Connectedness**			
	A	Separated sets, disconnectedness, totally disconnectedness, maximal connected set			CO5
	B	component and path, locally connected and based examples			CO5
	C	Urysohn's theorem (proof).			CO5
	Unit 5	**Nets**			
	A	Binary relation, Directed set, residual subset, sequence convergence of a set			CO6
	B	cluster point, subnet. **Filters:** Filter, Cofinite filter, neighbourhood filter, filter base			CO6
	C	convergent filter and Zorn's lemma			CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		25%	25%	50%	
	Text book/s*	1. S. Kumaresan, Topology of Metric Spaces, 2nd Ed., Narosa Publishing House, 2011. 2. Dugundji, James, Topology, Allyn and Bacon Series in Advanced Mathematics, Allyn and Bacon, Inc., Boston, Mass.-London-Sydney, 1978.			
	Other References	1. Munkres, James R, Topology: A First Course, Prentice-Hall, Inc., Englewood Cli_s, N.J., 1975. 2. Kelley, John L., General Topology, Graduate Texts in Mathematics, No. 27, Springer-Verlag, New York-Berlin, 1975.			

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
MMT107.1	3	3	3	3	2	3	3	2	1
MMT107.2	3	2	3	3	3	3	2	1	2
MMT107.3	2	2	2	3	2	2	2	1	1
MMT107.4	2	2	1	2	2	2	3	1	1
MMT107.5	3	2	2	3	2	3	2	2	2
MMT107.6	3	2	1	3	2	2	2	1	2

DIFFERENTIAL GEOMETRY & TENSOR ANALYSIS (MMT 108)

School: SSES		**Batch: 2025-27**
Programme: M. Sc.		**Academic Year: 2025-26**
Branch: Mathematics		**Semester: II**
1	Course Code	**MMT 108**
2	Course Title	**DIFFERENTIAL GEOMETRY & TENSOR ANALYSIS**
3	Credits	4
4	Contact Hours (L-T-P)	4-0-0
	Course Status	Compulsory
5	Course Objective	1. Familiarise students with basic concept of local theory of curves: space curves, e.g., plane curves, tangent and normal and binormal; Osculating plane, normal lines and normal plane, curvature and torsion, rectifying plane; Helices, arc length, Serret-Frenet formulae. Have an idea of Bertrand curves and its properties, Contact between curve and surfaces, tangent surfaces, tangent vectors and vector fields, Fundamental theorems for space curves, involutes and evolutes of curves, Metric-first fundamental form and second fundamental form. 2. Have an understanding of Normal curvature, quadratic form of normal curvature, mean curvature, Gaussian curvature and minimal surface, geodesics, canonical geodesic equations, normal properties of geodesics, geodesics curvature, lines of curvature, Rodrigue's formula. Know about Tensor calculus, Vector spaces, the dual spaces, tensor product of vector spaces, transformation formulae, contraction, inner product and outer product of two tensor. To know Contra variant and covariant tensors, mixed tensors of higher order, symmetric and skew-symmetric tensors, Quotient theorem, Reciprocal tensors, metric tensor, conjugate metric tensor with examples. Christoffel's symbols, covariant differentiation and Riemannian curvature tensor.
6	Course Outcomes	CO1: Describe the concept of local theory of curves: space curves, Osculating plane, normal lines and normal plane and explain curvature and torsion rectifying plane; Helices, arc length, Serret-Frenet formulae. (K1,K2,K4) CO2: Explain the theory of curves: Bertrand curves, Contact between curve and surfaces, tangent surfaces, tangent vectors and vector fields and write Fundamental theorems for space curves, involutes and evolutes of curves describe Metric-first fundamental form and second fundamental form. (K2,K4,K6) CO3: Discuss the concept of curvature and evaluate normal curvature, quadratic form of normal curvature, mean curvature, Gaussian curvature and minimal surface, geodesics, canonical geodesic equations, normal properties of geodesics, geodesics curvature, lines of curvature, Rodrigue's formula. (K1,K2,K5) CO4: Explain Tensor calculus, Vector spaces, and the dual spaces, tensor product of vector spaces, transformation formulae, and contraction; evaluate inner product and outer product of two tensor. (K2,K4,K5) CO5: Describe the concept of contra variant and covariant tensors, mixed tensors of higher order, symmetric and skew-symmetric tensors. (K1,K2) CO6: Write the Quotient theorem, Reciprocal tensors, metric tensor, illustrate conjugate metric tensor with examples. Christoffel's symbols, covariant differentiation and Riemannian curvature tensor.(K3,K6)

7	Course Description	This course is an introduction to differential geometry and tensor analysis. The primary objective of the course is to develop the advance understanding of differential geometry and tensor analysis.			
8	Outline syllabus				CO Mapping
	Unit 1	**Review of local theory of curves**			
	A	Space curves, e.g., plane curves, tangent and normal and binormal			CO1
	B	Osculating plane, normal lines and normal plane, curvature and torsion			CO1
	C	Rectifying plane; Helices, arc length, Serret-Frenet formulae.			CO1
	Unit 2	**Theory of Curves**			
	A	Bertrand curves and its properties, Contact between curve and surfaces, tangent surfaces, tangent vectors and vector fields			CO2
	B	Fundamental theorems for space curves, involutes and evolutes of curves			CO2
	C	Metric-first fundamental form and second fundamental form.			CO2
	Unit 3	**Curvature**			
	A	Normal curvature, quadratic form of normal curvature, mean curvature			CO3
	B	Gaussian curvature and minimal surface, geodesics, canonical geodesic equations			CO3
	C	Normal properties of geodesics, geodesics curvature, lines of curvature, Rodrigue's formula			CO3
	Unit 4	**Tensor calculus**			
	A	Tensor calculus, Vector spaces, the dual spaces			CO4
	B	Tensor product of vector spaces, transformation formulae, contraction			CO4
	C	Inner product and outer product of two tensor			CO4
	Unit 5	**Contra variant and covariant tensors**			
	A	Contra variant and covariant tensors, mixed tensors of higher order, symmetric and skew-symmetric tensors			CO5
	B	Quotient theorem, Reciprocal tensors, metric tensor, conjugate metric tensor with examples			CO6
	C	Christoffel's symbols, covariant differentiation and Riemannian curvature tensor.			CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		25%	25%	50%	
	Text book/s*	1. Elementary Differential Geometry, Revised 2nd Edition,			

		by Barrett O'Neill 2. Differential Geometry by J.J Stoker, John Wiley and Sons.	
	Other References	2. Schaum's Outline Series of Differential Geometry	

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
MMT108.1	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**1**
MMT108.2	**3**	**2**	**3**	**3**	**2**	**3**	**2**	**1**	**2**
MMT108.3	**2**	**2**	**3**	**2**	**3**	**2**	**2**	**2**	**1**
MMT108.4	**2**	**2**	**1**	**2**	**2**	**2**	**3**	**1**	**2**
MMT108.5	**3**	**2**	**2**	**3**	**2**	**3**	**2**	**2**	**2**
MMT108.6	**3**	**2**	**1**	**3**	**2**	**2**	**2**	**1**	**2**

School: SSES		**Batch: 2025-27**	
Programme: M.Sc.		**Academic Year: 2025-26**	
Branch: Mathematics		**Semester: III**	
1	Course Code	MMT204	
2	**Course Title**	**FLUID DYNAMICS**	
3	Credits	**4**	
4	Contact Hours (L-T-P)	4-0-0	
	Course Status	Compulsory	
5	Course Objective	The goal of this course is to introduce the necessary mathematical concepts for analysing fluid dynamics. Learn to perform integral analyses and overall balances from conservation laws and differential equations analyses for fields. Understand modelling approximations such as inviscid, incompressible, and turbulent for different types of flows.	
6	Course Outcomes	CO1: Explain the definition, properties and classification of fluid; define Pascal's law and write basic hydrostatic equation, Buoyancy and Archimedes' principle. (K1, K2,K4,K6) CO2: Describe the streamlines, path lines and streak lines, steady/unsteady, uniform/non-uniform, one-two dimensional flows and evaluate velocity and acceleration in an Eulerian flow field. (K1,K2,K5) CO3: Explain equations for stream function, velocity potential function in rectangular and cylindrical co-ordinates and discuss the concept of equations for source, sink, irrotational vortex, circulation.(K1,K2,K4) CO4: Explain and apply Integral equations for the control volume: using Reynold's Transport theorem. (K2,K3,K4) CO5: Explain equations for conservation of mass, energy and momentum and write Bernoulli's equation and its application. (K2,K4,K6) CO6: Apply Mass conservation in 2 dimension in rectangular co-ordinates, Euler's equations in 2,3 dimensions and subsequent derivation of Bernoulli's equation and write Navier-Stokes equations.(K3,K4,K6)	
7	Course Description	This course is an introduction to basics concept of velocity field, fluid statics, basic conservation laws for systems and control volumes, dimensional analysis and similitude, Euler and Bernoulli equations, NavierStokes equations, viscous flows, boundary-layer flow in channels and around submerged bodies, applications.	
8	Outline syllabus	**FLUID DYNAMICS**	CO Mapping
	Unit 1		
	A	Fluid Definition and properties, Newton's law of viscosity concept of continuum, Classification of fluids.	CO1
	B	Definition of body and surface forces, Pascal's law, Basic hydrostatic equation,	CO1

	C	Forces on surfaces due to hydrostatic pressure, Buoyancy and Archimedes' principle.			CO1
	Unit 2				
	A	Eulerian and Lagrangian approach to solutions; Velocity and acceleration in an Eulerian flow field;			CO2
	B	Definition of streamlines, path lines and streak lines; Definition of steady/unsteady, uniform/non-uniform, one-two dimensional flows;			CO2
	C	Definition of control volume and control surface, Understanding of differential and integral methods of analysis			CO2
	Unit 3				
	A	Definition and equations for stream function, velocity potential function in rectangular and cylindrical co-ordinates			CO3
	B	Rotational and irrotational flows;			CO3
	C	Definition and equations for source, sink, irrotational vortex, circulation.			CO3
	Unit 4				
	A	Integral equations for the control volume: Reynold's Transport theorem (without proof),			CO4
	B	Equations for conservation of mass, energy and momentum,			CO5
	C	Bernoulli's equation and its application			CO5
	Unit 5				
	A	Differential equations for the control volume: Mass conservation in 2 dimension in rectangular co-ordinates,			CO6
	B	Euler's equations in 2,3 dimensions and subsequent derivation of Bernoulli's equation;			CO6
	C	Navier-Stokes equations (without proof) in rectangular Cartesian co-ordinates			CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		25%	25%	50%	
	Text book	1. Fluid Mechanics : Streeter and Wylie, McGraw Hill			
	Other References	1. Fluid Mechanics :F.M.White, McGraw Hill 2. Fluid Dynamics, M. D. Raisinghania, S Chand Group			

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
MMT204.1	3	3	3	3	3	3	3	2	1
MMT204.2	3	2	3	3	2	3	2	1	2
MMT204.3	2	3	2	2	3	2	2	1	2
MMT204.4	2	2	1	3	2	2	3	2	1
MMT204.5	3	2	2	3	2	3	2	2	2
MMT204.6	3	2	2	3	2	2	2	2	2

ORDINARY AND PARTIAL DIFFERENTIAL EQUATIONS (MMT105)

School: SSES		**Batch: 2025-27**	
Programme: M. Sc.		**Academic Year: 2025-26**	
Branch: Mathematics		**Semester: II**	
1	Course Code	**MMT105**	
2	Course Title	**ORDINARY AND PARTIAL DIFFERENTIAL EQUATIONS**	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
	Course Status	Compulsory	
5	Course Objective	• Familiarise students with basic concepts of ordinary and partial differential equations and learn to solve first-order ordinary differential equations and formation of ODEs. • Explore the methods to solve linear differential equation of nth order with constant coefficients and variable coefficients. Students will also master the technique of separation of variables to solve PDEs and able to derive heat and wave equations.	
6	Course Outcomes	CO1: Explain and illustrate how to form the ordinary differential equations and solve the equations of first order and first degree. (K2,K3,K4) CO2: Describe and solve the linear differential equation of nth order with constant coefficients. (K1, K2, K3) CO3:. Explain Cauchy Euler's equations and solve the same, evaluate simultaneous linear differential equations by method of variation of parameters. (K2,K3,K4,K5) CO4: Describe the classification of PDEs of second order and evaluate the wave equation by using method of separation of variable. (K1,K2,K5) CO5: Evaluate the heat equation in one dimension in various cases. (K5) CO6: Explain and then evaluate Laplace equation. (K2, K4, K5)	
7	Course Description	This course is an introduction to ordinary and partial differential equations. The primary objective of the course is to develop the advance understanding of ordinary and partial differential equations.	
8	Outline syllabus		CO Mapping
	Unit 1		
	A	Basics of differential equations including order, degree, type of differential equation and formation of differential equations.	CO1
	B	Equations of first order and first degree including separation of variables, homogeneous and exact differential equations (including integrating factor).	CO1
	C	Linear differential equations. .	CO1
	Unit 2		
	A	Linear differential equation of nth order with constant coefficients, auxiliary equations	CO2

	B	auxiliary equations, complementary functions			CO2
	C	particular integrals for various standard functions and their combinations			CO2
	Unit 3				
	A	Cauchy Euler's equations and equations reducible to homogeneous form			CO3
	B	Simultaneous linear differential equations			CO3
	C	method of variation of parameters			CO3
	Unit 4				
	A	Classification of PDEs of second order, Boundary value problems, the principle of superposition			CO4
	B	method of separation of variables, its application to solve wave equation			CO4
	C	D'Alembert's solution of wave equation in various cases..			CO4
	Unit 5				
	A	Solution of heat equation in one dimension in various cases			CO5
	B	solution of Laplace equation in Cartesian coordinates			CO6
	C	its conversion into polar coordinates.			CO6
	Mode of examination	Theory/Jury/Practical/Viva			
	Weightage Distribution	CA	MTE	ETE	
		25%	25%	50%	
	Text book/s*	1. Ordinary and Partial Differential equations by M. D. Raisinghania, S Chand and Company Ltd. 2. Schaum's Outline Series of Partial Differential equations 3. Schaum's Outline Series of Ordinary Differential equations .			
	Other References	1. An introduction to Ordinary Differential Equations by Earl. A. Codington, DOVER PUBLICATIONS, INC. New York. 2. Elements of Partial Differential Equations by Ian N. Sneddon, McGRA-HILL Book Company.			

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
MMT105.1	3	3	3	3	3	3	3	2	1
MMT105.2	3	2	3	3	2	3	2	1	2
MMT105.3	2	2	3	2	2	2	3	2	1
MMT105.4	2	2	1	2	2	2	3	1	2
MMT105.5	3	2	2	3	2	3	2	2	2
MMT105.6	3	2	1	3	2	2	2	2	2

School: SSES		**Batch: 2025-27**	
Programme: M.Sc.		**Academic Year: 2025-26**	
Branch: Mathematics		**Semester: II**	
1	Course Code	MTP4253	
2	Course Title	Numerical Analysis Lab	
3	Credits	1	
4	Contact Hours (L-T-P)	0-0-2	
	Course Status	Compulsory	
5	Course Objective	• To familiarize the student in introducing and exploring MATLAB software. • To enable the student on how to approach for solving problems using MATLAB tools. • To prepare the students to use MATLAB in their project works. • To provide a foundation in use of this software for real time applications.	
6	Course Outcomes	CO1: Understand the procedures, algorithms, and concepts require to solve specific problems. (K2) CO2: Discuss and develop the algorithms to solve system of linear equations and measure the accuracy. (K2, K5, K6) CO3: Discuss and develop the algorithms to solve finite differences and interpolation and measure the accuracy. (K2, K5, K6) CO4: Discuss and develop the algorithms to solve system of transcendental equations and measure the accuracy. (K2, K5, K6) CO5: Discuss and develop the algorithms to solve divided differences and measure the accuracy. (K2, K5, K6) CO6: Discuss and develop the algorithms to solve numerical differentiation and integration and measure the accuracy. (K2, K5, K6)	
7	Course Description	This course teaches computer Programmeming to those with little to no previous experience. It uses the Programmeming system and language called MATLAB to do so because it is easy to learn, versatile and very useful for engineers and other professionals. MATLAB is a special-purpose language that is an excellent choice for writing moderate-size Programmes that solve problems involving the manipulation of numbers.	
8	Outline syllabus		CO Mapping
	Unit 1		
		Practical based on Bisection and Newton Raphson method	CO1, CO2
	Unit 2		
		Practical related to --Gauss Jacobi and Gauss Seidel method Gauss-Jacobi and Seidel with convergence criteria	CO1, CO3
	Unit 3		

		Practical related to--- Newton 's forward and backward interpolation, Trapezoidal rule.			CO1, CO4
	Unit 4				
		Practical related to--- Euler's and Runge Kutta method			CO1,CO5
	Unit 5				
		Practical related to---Laplace's and Poison's equation.			CO1, CO6
	Mode of examination	Practical			
	Weightage Distribution	CA	CE	ETE	
		30%	30%	40%	
	Text book/s*	Amos Gilot			
	Other References				

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
MTP4253.1	**3**	**3**	**2**	**2**	**2**	**3**	**2**	**2**	**3**
MTP4253.2	**2**	**3**	**3**	**2**	**3**	**2**	**3**	**3**	**2**
MTP4253.3	**2**	**3**	**2**	**2**	**3**	**3**	**3**	**2**	**3**
MTP4253.4	**2**	**3**	**2**	**3**	**2**	**2**	**2**	**2**	**2**
MTP4253.5	**3**	**3**	**2**	**3**	**2**	**2**	**3**	**3**	**3**
MTP4253.6	**2**	**3**	**2**	**3**	**2**	**2**	**2**	**2**	**2**

Project (MTR4854)

School: SSES	**Batch: 2025-27**	
Program: M.Sc.	**Academic Year: 2025-26**	
Branch: Mathematics	**Semester: II**	
Course Code	**MTR4854**	
Course Title	**Project**	
Credits	4	
Contact Hours (L-T-P)	0-0-8	
Course Status	Compulsory	
Course Objective	This course introduces students to problem identification, literature review, and data collection for a Mathematics project.	
Course Outcomes	CO1: Identify a research problem and define objectives. (K2, K3) CO2: Conduct literature review and feasibility study. (K3) CO3: Collect, organize, and preprocess relevant data. (K3, K4) CO4: Analyze data to explore patterns and relationships. (K4) CO5: Develop a structured project proposal. (K5) CO6: Present initial findings in a report and presentation. (K5, K6)	
Course Description	This course introduces students to problem identification, literature review, and data collection for a Mathematics project. It helps students develop a structured approach to research, establish objectives, and prepare a comprehensive project proposal.	
Outline syllabus		CO Mapping
Unit 1	**Project Planning and Problem Identification**	
A	Selection of a topic and defining project scope	CO1
B	Literature review and feasibility analysis	CO1
C	Setting research objectives and expected outcomes	CO1
Unit 2	**Data Collection and Organization**	
A	Identifying sources of data	CO2
B	Collection, structuring, and documentation of data	CO2
C	Handling and managing missing or inconsistent data	CO2
Unit 3	**Initial Data Analysis**	
A	Exploring data characteristics	CO3
B	Identifying trends, patterns, and correlations	CO3
C	Generating preliminary insights	CO3
Unit 4	**Project Proposal Development**	
A	Outlining project methodology and approach	CO4
B	Identifying evaluation criteria	CO4
C	Addressing potential challenges and limitations	CO4
Unit 5	**Presentation and Review**	
A	Structuring and formatting the proposal	CO5
B	Preparing visual and written reports	CO6
C	Presenting and refining based on feedback	CO6
Mode of examination		

Weightage Distribution	CA	CE	ETE	
	30%	30%	40%	
Text book/s*	• The Data Science Handbook – Carl Shan, Henry Wang, William Chen, and Max Song • Practical Research: Planning and Design – Paul D. Leedy and Jeanne Ellis Ormrod			
Other References	• Exploratory Data Analysis with Python – John W. Tukey • The Craft of Research – Wayne C. Booth, Gregory G. Colomb, Joseph M. Williams			

COURSE OUTCOMES– PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
MTR4854.1	**3**	**2**	**3**	**3**	**2**	**3**	**2**	**3**	**3**
MTR4854.2	**3**	**2**	**3**	**3**	**2**	**3**	**2**	**3**	**3**
MTR4854.3	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**3**	**3**
MTR4854.4	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**
MTR4854.5	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**
MTR4854.6	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**

Abstract Algebra(MTT5301)

School: SSES		**Batch: 2025-27**	
Programme: M. Sc.		**Academic Year: 2026-27**	
Branch: Mathematics		**Semester: III**	
1	Course Code.	MTT5301	
2	Course Title	**ABSTRACT ALGEBRA**	
3	Credits	5	
4	Contact Hours (L-T-P)	5-0-0	
	Course status	Compulsory	
5	Course Objective	1. To familiarise students with basic concepts of group, subgroup, quotient group and permutation groups, and given an idea of the normal subgroup, sylow groups, internal and external direct product. 2. To make students familiar with the concept of homomorphism, isomorphism, automorphism and inner- automorphism, different algebraic structures ring, integral domain, field, ideal and quotient ring, prime and maximal ideal, Irreducible polynomials, principal ideal domains and unique factorization domains. Know about Extension of fields: algebraic extensions, roots of polynomials and splitting fields.	
6	Course Outcomes	CO1: Explain and illustrate the concept of group, subgroup, quotient group and permutation groups.(K2,K3,K4) CO2: Describe the normal subgroup, sylow groups and evaluate internal and external direct product. (K1,K2,K5) CO3: Explain the concepts of homomorphism, isomorphism and analysis automorphism and inner- automorphism. (K2,K4) CO4: Discuss about ring integral domain, field ideal and quotient ring, prime and maximal ideal. (K2) CO5: Evaluate irreducible polynomials, principal ideal domains and unique factorization domains. (K5) CO6: Explain about Extension of fields: algebraic extensions and evaluate roots of polynomials and splitting fields. (K2,K4,K5)	
7	Course Description	This course is an introduction to concept of groups, normal subgroups. The primary objective of the course is to develop the understanding of rings and fields.	
8	Outline syllabus		CO Mapping
	Unit 1	**Review of Groups**	
	A	Group, Subgroups, quotient groups,	CO1
	B	Permutation group,Cyclic groups,	CO1
	C	Lagrange's theorem and the result about its converse, Dihedral Groups.	CO1
	Unit 2	**Normal Subgroups and Sylow theorem**	
	A	Normal subgroups and factor groups and applications.	CO2
	B	Cauchy's and Sylow's theorems and applications,	CO2
	C	Finitely generated Abelian groups, internal and external direct products. Examples.	CO2

	Unit 3	**Homomorphism and Isomorphism**			
	A	Introduction to group homomorphisms and their properties, including the kernel of a homomorphism and the Fundamental Theorem of Homomorphisms. inner automorphisms.			CO3
	B	Definitions and examples of isomorphisms, automorphisms, and			CO3
	C	Inner automorphisms.			CO3
	Unit 4	**Ring Theory**			
	A	An overview of rings, integral domains, and fields, including the concepts of ideals and quotient rings, subfields, the			CO4
	B	prime and maximal ideals. Study of polynomial rings, irreducible polynomials, and			CO4, CO5
	C	Eisenstein Criterion, along with principal ideal domains (PIDs) and unique factorization domains (UFDs).			CO4, CO5
	Unit 5	**Extension of fields**			
	A	Algebraic extensions			CO6
	B	Roots of polynomials			CO6
	C	Splitting fields			CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		25%	25%	50%	
	Text book/s*	1. Joseph Gallian, contemporary Abstract algebra, seventh edition USA. 2. P. B. Bhatacharya, S. K. Jain and S. R. Nagpal, Basic Abstract Algebra (2nd Edition) Cambridge University Press, Indian Edition, 1977.			
	Other References	1. I. N. Herstain, Topics in Algebra, Wiley Eastern Ltd., New Delhi, 1975. 2. N. Jacobson, Basic Algebra, Vol I & II, W.H. Freeman, 1980 (also published by Hindustan Publishing Company). 3. V. K. Khanna and S. K. Bhamri, A course in abstract Algebra, 3rd.Ed. 2008. 4. N.S. Gopalakrishnan: University Algebra.			

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
MTT5301.1	3	3	3	3	3	3	3	2	1
MTT5301.2	3	2	3	3	2	3	2	1	2
MTT5301.3	2	2	2	3	3	2	2	1	1
MTT5301.4	2	2	2	3	2	2	3	2	2
MTT5301.5	3	2	2	3	2	3	2	2	2
MTT5301.6	3	2	1	3	2	2	2	1	2

Functional Analysis(MTT5302)

School: SSES		**Batch: 2025-27**	
Programme: M.Sc.		**Academic Year: 2026-27**	
Branch: Mathematics		**Semester: III**	
1	Course Code	MTT5302	
2	Course Title	**FUNCTIONAL ANALYSIS**	
3	Credits	5	
4	Contact Hours (L-T-P)	5-0-0	
	Course Status	Compulsory	
5	Course Objective	To familiarise students with basic concepts of Functional analysis and given an idea of implemented the concepts of Elementary understanding of Normed linear spaces. Can perform basic Bounded linear operator and Know how to calculate system of Inner product spaces. Understand the basic concept of functional analysis and learn basic definitions and terminology associated with to functional analysis.	
6	Course Outcomes	CO1: Describe the basics of functional analysis, normed linear spaces, Holder's inequality, Minkowski's inequality and explain l^p -spaces, equivalence of norms and calculate banach spaces. (K2, K3, K4) CO2: Explain bounded linear spaces, finite dimensional normed space and compactness and evaluate dual of normed spaces $\Re^n$; l^p also of C[a, b]). (K2,K4,K5) CO3: Discuss the concept of open mapping and closed graph theorems, explain uniform boundedness principle and its applications.(K1,K2,K4) CO4: Write Hahn-Banach theorem and its consequence. (K6) CO5: Illustrate Inner product spaces, Hilbert spaces with examples and write Projection theorem, Bessel's inequality, existence of complete orthonormal basis of a Hilbert space Riesz representation theorem. (K3,K6) CO6: Describe the concept of bounded linear functional, Hilbert adjoint operator, self adjoint operator, Compact operators and write Riesz-Schauder theorem. (K1,K2,K6)	
7	Course Description	The primary objective of the course is to develop the understanding the normed linear spaces, bounded linear operator, open mapping and closed graph theorems and Inner product spaces.	
8	Outline syllabus		CO Mapping
	Unit 1	**Normed linear spaces**	
	A	Normed linear spaces, Holder's inequality, Minkowski's inequality	CO1
	B	l^p -spaces, equivalence of norms, equivalence of norms on a finite dimensional space, Riesz lemma,	CO1
	C	Banach spaces, examples	CO1
	Unit 2	**Bounded linear operator**	
	A	Bounded linear operator, spaces of bounded linear operator	CO2
	B	Finite dimensional normed space and compactness	CO2
	C	Dual of normed spaces $\Re^n$; l^p also of C[a, b]).	CO2
	Unit 3	**Open mapping**	

	A	Results and examples based on open mapping and closed graph theorems,			CO3
	B	Uniform boundedness principle and its applications			CO3
	C	Hahn-Banach theorem and its consequence.			CO3, CO4
	Unit 4	**Inner product spaces**			
	A	Introduction to inner product spaces and Hilbert spaces, along with key results and illustrative examples			CO5
	B	. Topics include the Projection Theorem, Bessel's Inequality, the existence of a complete orthonormal basis in a Hilbert space, and			CO5
	C	the Riesz Representation Theorem.			CO5
	Unit 5	**Bounded linear functional**			
	A	Study of bounded linear functionals, their properties and key results;			CO6
	B	Hilbert adjoint and self-adjoint operators; compact operators and			CO6
	C	the Riesz–Schauder Theorem; and the theory of self-adjoint compact operators.			CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		25%	25%	50%	
	Text book/s*	[1] Kreyszig, Erwin, Introductory Functional Analysis with Applications, Wiley Classics Library, John Wiley & Sons, Inc., New York, 1989. [2] Limaye, Balmohan V., Functional Analysis, second edition, New Age International Publishers Limited,			
	Other References				

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
MTT5302.1	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**2**
MTT5302.2	**3**	**2**	**3**	**3**	**2**	**3**	**3**	**1**	**1**
MTT5302.3	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**
MTT5302.4	**2**	**2**	**1**	**2**	**3**	**2**	**3**	**1**	**1**
MTT5302.5	**3**	**2**	**2**	**3**	**2**	**3**	**2**	**2**	**2**
MTT5302.6	**3**	**2**	**1**	**3**	**2**	**2**	**2**	**1**	**2**

School: SSES		**Batch: 2025-26**	
Programme: M.Sc.		**Academic Year: 2026-27**	
Branch: Mathematics		**Semester: III**	
1	Course Code	MTT5303	
2	**Course Title**	**Graph Theory and its Application**	
3	Credits	**3**	
4	Contact Hours (L-T-P)	3-0-0	
	Course Status	Compulsory	
5	Course Objective	The goal of this course is to introduce the necessary mathematical concepts of relevant vocabulary from graph theory and combinatory, and know the statements and proofs of many of the important theorems in the subject, and be able to perform related calculations.	
6	Course Outcomes	CO1: Describe the basic concept of graphs and evaluate distances, radius, diameter, centre of a graph, the number of distinct spanning trees in a complete graph. (K2,K4,K5) CO2: Explain the concept of tree and write Kruskal and Prim algorithms, Huffman's algorithm. (K2,K4,K6) CO3: Discuss about matching of graphs and write the theorems related to matching. (K1,K2,K6) CO4: Describe graph colouring, chromatic number, bounds on chromatic numbers and write Greedy algorithm. (K2,K6) CO5: Discuss interval graphs and chordal graphs, chromatic polynomials and write Brook's theorem. (K1, K2, K6) CO6: Explain Hamilton property, Non-Hamiltonian graphs, Non-planarity of K5 and K3,3, classification of regular polytopes and write 5-colour theorem. (K2,K4,K6)	
7	Course Description	This course covers the theory of graphs and networks for both directed and undirected graphs. Topics include graph isomorphism, Eulerian and Hamiltonian graphs, matching, covers, connectivity, coloring, and planarity. There is an emphasis on applications to real world problems and on graph algorithms such as those for spanning trees, shortest paths, and network flows.	
8	Outline syllabus	**Advance Graph Theory and its Application**	CO Mapping
	Unit 1	**Basic Concepts of graphs**	
	A	Definition and theorems on various kinds of graphs, simple graphs, complete graph, walk, tour, path and cycle, Eulerian graph, bipartite graph (characterization).	CO1
	B	Hand shaking lemma, Havel-Hakimi theorem and Erdos-Gallai theorem (statement only), Petersen graph, trees, forests and spanning subgraphs.	CO1
	C	Distances, radius, diameter, center of a graph, the number of distinct spanning trees in a complete graph.	CO1

	Unit 2	**Trees:**			
	A	Study of graph algorithms including Kruskal's and Prim's algorithms with proofs of correctness,			CO2
	B	Dijkstra's algorithm, and traversal methods such as breadth-first and depth-first search trees.			CO2
	C	Rooted and binary trees, as well as Huffman's algorithm.			CO2
	Unit 3	**Matching:**			
	A	Exploration of augmenting paths and Hall's Matching Theorem, along with concepts like vertex and edge covers, independence number, and their interconnections. Connectivity, including k-vertex and edge connectivity, blocks, and characterizations of 2-connected graphs. Key theorems such as Menger's Theorem and its applications,			CO3
	B	Connectivity, including k-vertex and edge connectivity, blocks, and characterizations of 2-connected graphs. Key theorems such as Menger's Theorem			CO3
	C	along with network flow problems, the Ford-Fulkerson Algorithm, and the Supply-Demand Theorem. Additionally, the Gale-Ryser Theorem on degree sequences of bipartite graphs.			CO3
	Unit 4	**Graph Colourings:**			
	A	Definition of chromatic number, Introduction to Greedy algorithm, bounds on chromatic numbers			CO4
	B	interval graphs and chordal graphs (with simplicial elimination ordering),			CO5
	C	, Brook's theorem and graphs with no triangles but large chromatic number, chromatic polynomials.			CO5
	Unit 5	**Hamilton property:**			
	A	Dirac's and Ore's theorems and their necessary conditions			CO6
	B	Non-Hamiltonian graphs with large vertex degrees Planar graphs and the concept of embedding graphs on a plane Euler's formula for planar graphs			CO6
	C	Non-planarity of K5 and K3,3 Classification of regular polytopes			CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		25%	25%	50%	
	Text book	1. B. West, Introduction to Graph Theory, Prentice Hall of India, 2001.			
	Other References	1. J. A. Bondy and U. S. R. Murty, Graph Theory with Applications, Springer-Verlag, 2008. 2. R. Diestel, Introduction to Graph Theory, Springer-Verlag, 2010.			

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
MTT5303.1	3	3	3	3	3	3	3	2	1
MTT5303.2	3	2	3	3	2	3	2	1	2
MTT5303.3	2	2	3	2	3	2	2	1	2
MTT5303.4	2	3	2	2	2	2	3	3	2
MTT5303.5	3	2	2	3	2	3	2	2	2
MTT5303.6	3	2	2	3	2	2	2	2	2

School: SSES		**Batch: 2025- 2027**
Program: M.Sc.		**Current Academic Year: 2026-27**
Branch: Mathematics		**Semester: III**
1	Course Code	MTT5310
2	Course Title	RM & IPR(Research Methodology & Intellectual Property Rights)
3	Credits	1
4	Contact Hours (L-T-P)	1-0-0
	Course Status	Compulsory
5	Course Objective	Aims to equip postgraduate students with a comprehensive understanding of research processes and the essentials of intellectual property protection. Introduce basic concepts of research, including its objectives, significance, and various methodologies. Enhance abilities in formulating research problems, conducting literature reviews, selecting appropriate research designs, and employing effective data collection and analysis techniques. Provide insights into various forms of intellectual property, such as patents, trademarks, and copyrights, and their significance in protecting innovations and creations.
6	Course Outcomes	CO1: Identify and define clear, concise research problems, establishing appropriate objectives and hypotheses. (K2, K4) CO2: Perform thorough literature searches, critically analyze existing research, and identify gaps to position new research effectively. (K3) CO3: Develop suitable research designs, select appropriate methodologies, and apply relevant data collection and analysis techniques., (K2, K4,K5) CO4: Recognize and adhere to ethical standards in research, addressing issues such as plagiarism, data fabrication, and authorship ethics. (K1, K2) CO5: Comprehend various forms of intellectual property, including patents, copyrights, and trademarks, and their significance in protecting innovations. (K1, K2) CO6: Understand the processes for filing intellectual property rights and the legal and economic implications of IPR in the global business environment. (K2, K6)
7	Course Description	This course covers the fundamentals of research design, data collection, and analysis, emphasizing ethical considerations and integrity in scholarly work. Students will learn to effectively formulate research problems, conduct literature reviews, and apply appropriate methodologies. Additionally, the course delves into various forms of intellectual property,

		including patents, copyrights, and trademarks, highlighting their significance in safeguarding innovations and creative works. By integrating these topics, the course prepares students to conduct rigorous research while navigating the legal frameworks that protect intellectual property.	
8	Outline syllabus		CO Mapping
	Unit 1		
	A	Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations	CO1
	Unit 2		
	A	Effective literature studies approaches, analysis Plagiarism, Research ethics,	CO2
	Unit 3		
	A	Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, its presentation and assessment by a review committee	CO3
	Unit 4		
	A	Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.	CO4
	B	Types of IPR: patents, trademarks, copyrights, industrial designs, trade secrets. Basics of patents: meaning, types, process of filing at national and international levels.	CO4
	C	Administration of patent systems, licensing, and technology transfer.	CO4
	Unit 5		
	A	Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications, Administration of Patent System.	CO6,CO5

	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		25%	25%	50%	
	Text books	Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students'" • Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction" • Ranjit Kumar, 2 ndEdition, "Research Methodology: A Step by Step Guide for beginners" • Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd,2007. • Mayall, "Industrial Design", McGraw Hill, 1992. • Niebel, "Product Design", McGraw Hill, 1974.			
	Other references	1. A. Gnana Soundari, S. Muthubalaji, and S. Gopalakrishnan: Research Methodology & IPR, Scholars' Press, 2024. 2. Kailas Pathade : Research Methodology and Intellectual Property Rights, Notion Press, 2024.			

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
MTT5310.1	**3**	**3**	**3**	**3**	**2**	**3**	**3**	**2**	**1**
MTT5310.2	**3**	**2**	**3**	**3**	**3**	**3**	**2**	**1**	**2**
MTT5310.3	**2**	**2**	**2**	**3**	**2**	**2**	**2**	**1**	**1**
MTT5310.4	**2**	**2**	**1**	**2**	**2**	**2**	**3**	**1**	**1**
MTT5310.5	**3**	**2**	**2**	**3**	**2**	**3**	**2**	**2**	**2**
MTT5310.6	**3**	**2**	**1**	**3**	**2**	**2**	**2**	**1**	**2**

DISSERTATION-I (MTR5352)

School: SSES		**Batch: 2025-27**	
Programme: M.Sc.		**Academic Year: 2026-27**	
Branch: Mathematics		**Semester: III**	
1	Course Code	MTR5352	
2	Course Title	DISSERTATION-I	
3	Credits	6	
4	Contact Hours (L-T-P)	0-0-12	
	Course Status	Compulsory/Elective	
5	Course Objective	• Deep knowledge of a specific area of specialization. • Develop communication skills especially in project writing and oral presentation. Develop some time management skills.	
6	Course Outcomes	CO1: Explain the concept of research within the subject, as regards approaching a question, collecting and analysing background material and presenting research questions and conclusions. (K2, K4) CO2: Construct and develop a deeper interest in mathematics and taste for research. (K5, K6) CO3: Select and recommend the activities that support their professional goals. (K4, K6) CO4: Develop effective project organizational skills. (K5) CO5. Discuss the ethical dimensions of your research and obtain appropriate ethical approval if needed. (K5) CO6. Plan a research article of the findings in an appropriate manner. (K6)	
7	Course Description	This course facilitates postgraduate mathematics students in independently conducting original research, culminating in a dissertation that contributes to the field of mathematics. Students will engage in formulating research problems, conducting literature reviews, developing methodologies, analyzing results, and presenting their findings.	
8	Outline syllabus		CO Achievement
	Unit 1	**Research Problem Identification and Proposal Development** • Identifying research gaps and selecting mathematical problems • Formulating precise research questions or hypotheses • Developing a research proposal, including objectives, significance, and methodology	**CO1**

	Unit 2	**Literature Review and Theoretical Framework** • Conducting systematic literature searches • Critically analyzing and synthesizing existing mathematical research • Establishing theoretical or conceptual frameworks			**CO1,CO2**
	Unit 3	• **Research Design and Methodology** • Selecting suitable mathematical methods and approaches • Designing data collection instruments and procedures, if applicable • Addressing ethical considerations and obtaining necessary approvals			**CO2,CO3**
	Unit 4	**Data Collection and Analysis** • Implementing data collection procedures, if applicable • Utilizing appropriate mathematical analysis techniques • Interpreting results in the context of research questions and theoretical framework			**CO3, CO4**
	Unit 5	**Dissertation Writing and Defense** • Structuring and writing the dissertation • Adhering to academic writing standards and citation styles • Preparing for and delivering the dissertation defense			**CO5,CO6**
	Mode of examination	Jury/Practical/Viva			
	Weightage Distribution	CA	CE	ETE	
		30%	30%	40%	
	Text book/s*	-			
	Other References				

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
MTR5352.1	3	3	2	2	2	3	2	3	3
MTR5352.2	2	3	3	2	3	2	3	3	2
MTR5352.3	2	3	2	2	3	3	3	3	3
MTR5352.4	2	3	2	2	2	3	2	3	2
MTR5352.5	2	2	2	3	3	3	3	3	3
MTR5352.6	2	2	2	3	3	3	3	3	3

School: SSES		**Batch : 2025-26**	
Program: M.Sc.		**Current Academic Year: 2026-27**	
Branch: Mathematics		**Semester: IV**	
1	Course Code	MTT5408	
2	Course Title	Operation Research and Industrial Applications	
3	Credits	5	
4	Contact Hours (L-T-P)	5-0-0	
	Course Status	Compulsory	
5	Course Objective	The objective of this course is to equip students with advanced concepts of Operation Research including optimization techniques, stochastic models, and decision analysis to solve real-world problems effectively.	
6	Course Outcomes	CO1: Formulate and solve complex linear programming problems using advanced methods. (K1, K3, K6) CO2: Implement advanced simplex techniques, and dual methods with economic interpretation. (K2,K3, K4) CO3: Develop and analyze stochastic models including Markov Chains, hidden Markov models, and queuing systems. (K2, K3, K6) CO4: Formulate and solve complex inventory models involving probabilistic demand, supply chain optimization. (K2, K4, K6) CO5: Understand game theory concepts including cooperative game theory and solve strategic decision problems. (K2,K4) CO6: Describe the concept of CPM and PERT and calculate float calculation and Cost reduction by Crashing of activities. (K1, K2,K3)	
7	Course Description	This course introduces advanced topics in Operation Research, focusing on sophisticated techniques for linear programming, stochastic models, inventory management, and decision theory to enhance analytical skills in solving real-life problems.	
8	Outline syllabus		CO Mapping
	Unit 1	**Advanced Linear Programming**	
	A	Formulation of LP problems	CO1
	B	Analytical Methods: Simplex, Big M, Primal and Dual Problems, Economic Interpretation and Dual Simplex Method. Sensitivity Analysis and Duality Concepts	CO1
	C	Assignment Problem, Transportation Problem(VAM, North West and Max-min)	CO1
	Unit 2	**Stochastic Models**	
	A	Introduction to Markov Chains, Hidden Markov Models, Transition Probability Matrix	CO2

	B	Queuing Models: M/M/1, M/M/c, Finite Queuing Models			CO2
	C	Applications of Stochastic Models in Real-Life Problems			CO2
	Unit 3	**Advanced Inventory Models**			
	A	Inventory classification, Different cost associated to Inventory. Economic order quantity, Inventory models with deterministic demands			CO3
	B	Multi-Echelon Inventory Models			CO3
	C	Inventory Control with Probabilistic Demand			CO3
	Unit 4	**Game Theory and Decision Analysis**			
	A	Zero-Sum Games, Pure and Mixed Strategy, Cooperative Game Theory			CO4
	B	Decision Trees and Bayesian Analysis			CO4
	C	Application of Game Theory in Industry			CO4, CO5
	Unit 5	**Project Management**			
	A	Introduction to PERT and CPM, critical Path calculation.			CO6
	B	Float calculation and its importance.			CO6
	C	Project Cost Analysis, Resource Optimization, and Risk Management			CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		25%	25%	50%	
	Text book/s*	1. Taha, H.A., Operations Research-An introduction, New York: MacMillan, 1992. 2. KantiSwarup, P. K. Gupta and Man Mohan: Operation Research ; S. Chand & Sons, New delhi.			
	Other References	1. Hadley, G., Linear Programming, Addison –Wesley, 1962. 2. Hillier, F.S. and G.J. Lieberman, Introduction to Operations Research-concept and cases, Asian Ed., Tata McGraw-Hill.			

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
MTT5408.1	3	3	3	3	3	3	3	2	1
MTT5408.2	3	2	3	3	2	3	2	1	2
MTT5408.3	2	2	2	2	2	1	2	2	1
MTT5408.4	2	2	1	3	2	2	3	1	1
MTT5408.5	3	1	2	3	2	3	2	2	2
MTT5408.6	3	2	1	3	2	2	2	1	1

School: SSES		**Batch: 2025-27**	
Program: M.Sc.		**Current Academic Year: 2026-27**	
Branch: Mathematics		**Semester: IV**	
1	Course Code	MTP5459	
2	Course Title	Operation Research Lab	
3	Credits	1	
4	Contact Hours (L-T-P)	0-0-2	
	Course Status	Compulsory	
5	Course Objective	This lab provides hands-on experience in solving optimization and decision-making problems using computational tools. The course focuses on implementing various optimization models, stochastic processes, game theory strategies, and project management techniques through software applications.	
6	Course Outcomes	CO1: Implement and solve linear programming problems using optimization software. (K2, K3, K5) CO2: Use computational methods for solving stochastic models and queuing systems. (K2, K3, K6) CO3: Apply inventory control techniques and supply chain optimization using simulation tools. (K2, K4, K6) CO4: Implement game theory strategies and analyze decision-making models. (K3, K4, K6) CO5: Develop project scheduling models using CPM, PERT, and Monte Carlo simulations. (K2, K4, K6) CO6: Calculate float calculation and Cost reduction by Crashing of activities.(K4, K5)	
7	Course Description	This lab-based course focuses on the **practical application** of advanced operation research and decision sciences using computational tools. Students will use software like MATLAB, Python, R, and Excel Solver to analyze and solve real-world problems.	
8	Outline syllabus		CO Mapping
	Unit 1	**Linear Programming Implementation**	
		Formulating and solving LP problems using MATLAB, Python, or R Implementing graphical, simplex, and dual simplex methods. Sensitivity analysis and economic interpretation of LP solutions.	CO1
	Unit 2	**Stochastic Models and Queuing Theory Applications** Simulating Markov Chains and Hidden Markov Models.	**CO2**

		Implementing M/M/1 and M/M/c queuing models. Case studies on stochastic model applications in industry.	
	Unit 3	**Inventory Management and Supply Chain Optimization** Implementing EOQ and multi-echelon inventory models. Solving inventory problems with probabilistic demand using R/Python. Case studies on inventory optimization in industries.	**CO3**
	Unit 4	**Game Theory and Decision Analysis** Implementing zero-sum and cooperative game strategies using Python. Decision Trees and Bayesian Analysis for risk assessment. Application of game theory in economics and business decisions.	**CO4**
	Unit 5	**Project Management Optimization** CPM and PERT implementation using project management tools. Monte Carlo simulation for risk analysis in project management. Optimization in resource allocation and scheduling.	**CO5**
	Mode of examination	Practical &Viva	
	Weightage Distribution	CA: 30% / CE: 30% / ETE: 40%	
	Text book	1. **Taha, H.A.**, "Operations Research: An Introduction", Pearson Education. 2. **Hillier, F.S. and G.J. Lieberman**, "Introduction to Operations Research", McGraw-Hill. 3. **Winston, W.L.**, "Operations Research: Applications and Algorithms", Thomson Brooks/Cole.	
	Other References	3. Getting started with Matlab: RudraPratap 4. MATLAB / Python (SciPy, NumPy, PuLP) 5. R (Optimization and Decision Packages) 6. Excel Solver / LINGO / AMPL	

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
MTP5459.1	3	3	2	2	2	3	2	2	3
MTP5459.2	2	3	3	3	3	2	3	3	2
MTP5459.3	2	3	2	2	3	3	3	3	3
MTP5459.4	2	3	2	3	2	2	2	3	2
MTP5459.5	3	3	2	3	2	2	3	2	3

DISSERTATION-2 (MTR5455)

School: SSES		**Batch: 2025-27**	
Programme: M.Sc.		**Academic Year: 2025-26**	
Branch: Mathematics		**Semester: IV**	
1	Course Code	MTR5455	
2	Course Title	DISSERTATION-2	
3	Credits	14	
4	Contact Hours (L-T-P)	0-0-28	
	Course Status	Compulsory/Elective	
5	Course Objective	• Deep knowledge of a specific area of specialization. • Develop communication skills especially in project writing and oral presentation. Develop some time management skills.	
6	Course Outcomes	CO1: Explain the concept of research within the subject, as regards approaching a question, collecting and analysing background material and presenting research questions and conclusions. (K2, K4) CO2: Construct and develop a deeper interest in mathematics and taste for research. (K5, K6) CO3: Select and recommend the activities that support their professional goals. (K4, K6) CO4**:** Develop effective project organizational skills. (K5) CO5. Discuss the ethical dimensions of your research and obtain appropriate ethical approval if needed. (K5) CO6. Plan a research article of the findings in an appropriate manner. (K6)	
7	Course Description	This course is the culmination of the postgraduate mathematics program, guiding students through the process of conducting original and substantial research. Students will formulate complex mathematical problems, engage deeply with existing literature, develop and apply advanced methodologies, analyze results rigorously, and present their findings in a scholarly dissertation.	
8	Outline syllabus		CO Achievement
	Unit 1	**Advanced Research Problem Formulation and Proposal Development** □ Identifying complex research gaps and selecting impactful mathematical problems □ Formulating precise and testable research questions or hypotheses □ Developing a comprehensive research proposal, including objectives, significance, and advanced methodology	**CO1**

	Unit 2	**Comprehensive Literature Review and Theoretical Framework** □ Conducting extensive literature searches using advanced mathematical databases □ Critically analyzing and synthesizing existing mathematical research □ Establishing comprehensive theoretical or conceptual frameworks	**CO1,CO2**
	Unit 3	**Advanced Research Design and Methodology** □ Selecting and justifying appropriate mathematical methods and approaches □ Designing data collection instruments and procedures, if applicable □ Addressing ethical considerations and obtaining necessary approvals	**CO2,CO3**
	Unit 4	**Data Collection and Analysis** □ Implementing data collection procedures, if applicable □ Utilizing appropriate mathematical analysis techniques □ Interpreting results in the context of research questions and theoretical framework	**CO3, CO4**
	Unit 5	**Dissertation Writing and Defense** □ Structuring and writing the dissertation □ Adhering to academic writing standards and citation styles □ Preparing for and delivering the dissertation defense	**CO5,CO6**
	Mode of examination	Jury/Practical/Viva	

	Weightage Distribution	CA	CE	ETE	
		30%	30%	40%	
	Text book/s*	-			
	Other References				

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
MTR5455.1	3	3	2	2	2	3	2	3	3
MTR5455.2	2	3	3	2	3	2	3	3	2
MTR5455.3	2	3	2	2	3	3	3	3	3
MTR5455.4	2	3	2	2	2	3	2	3	2
MTR5455.5	2	2	2	3	3	3	3	3	3
MTR5455.6	2	2	2	3	3	3	3	3	3

School: SSES		**Batch: 2025-27**	
Programme: M.Sc.		**Academic Year: 2026-27**	
Branch: Mathematics		**Semester: III**	
1	Course Code	MTT5304	
2	Course Title	Number Theory with Cryptography	
3	Credits	5	
4	Contact Hours (L-T-P)	5-0-0	
	Course Status	Compulsory	
5	Course Objective	To make students familiar with the basic concepts of number theory, congruence. Also students are able to understand public & private key cryptography.	
6	Course Outcomes	CO1: Explain the basic concepts of number theory and calculate GCD, LCM; write factorization theorem, Euclid theorem, and Prime number theorem. (K2,K3,K4,K6) CO2: Discuss about congruences along with solutions, residue system, write Fermat's little theorem, Wilson theorem, Chinese remainder theorem, Hansel lemma and calculate Primitive roots. (K1,K2,K5,K6) CO3: Describe classical encryption techniques, Substitution ciphers and transposition ciphers, modern block ciphers principles, public & private key cryptography, write RSA algorithm. (K2,K6) CO4: Discuss and write Gauss lemma, Legendre symbol, quadrqtic reciprocity law, Jacobi symbol.(K2,K6) CO5: Explain the greatest integer function, Euler's totient function, the number of divisors function.(K2,K4) CO6: Discuss and evaluate the sum of divisors function, Mobius mu function, Mobius inversion formula. (K1,K2,K5)	
7	Course Description	This course is an introduction to basics of number theory with cryptography, congruences, quadratic residues, some standard arithmetic functions.	
8	Outline syllabus :**Number theory with Cryptography (MTT-204)**		CO Mapping
	Unit 1	**BASICS**	

	A	Definitions and results based on primes, Divisibility, Euclid's algorithm, GCD, LCM, expressing.	CO1
	B	GCD as a linear combination of the numbers, Unique factorization theorem, Euclid's theorem on infinitude of primes.	CO1
	C	Idea of existence of large gaps between primes, Statement of prime number theorem.	CO1
	Unit 2	**CONGRUENCES**	
	A	Definition based on Residue system modulo m, Fermat's little theorem, Euler's generalization of Fermat's theorem.	CO2
	B	Wilson's theorem, Solution of congruences, Chinese remainder theorem.	CO2
	C	Hansel's lemma, Prime power moduli, Primitive roots, examples and results.	CO2
	Unit 3	**CRYPTOGRAPHY**	
	A	Classical encryption techniques, Substitution ciphers and transposition ciphers, Modern block ciphers and Block ciphers principles.	CO3
	B	Public key Cryptography: Public keys , Encrypting the message.	CO3
	C	Private keys, decrypting and retrieval of the original message (RSA algorithm).	CO3
	Unit 4	**QUADRATIC RESIDUES**	
	A	Statement of Gauss lemma and results	CO4
	B	Legendre symbol, Jacobi symbol.	CO4
	C	Quadratic reciprocity law.	CO4
	Unit 5	**SOME STANDARD ARITHMETIC FUNCTIONS**	
	A	Definition of the greatest integer function with examples, Euler's totient function with examples.	CO5
	B	The number of divisors function, The sum of divisors function.	CO6

	C	Mobius mu function, Mobius inversion formula.			CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		25%	25%	50%	
	Text book/s*	• Ivan Niven , Herbert S. Zuckerman , Hugh L. Montgomery: An Introduction to the theory of numbers , John Wiley and Sons (Asia) Pvt. Ltd.			
	Other References	G. H. Hardy & E. M. Wright : An Introduction to the theory of Numbers.			

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
MTT5304.1	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**1**
MTT5304.2	**3**	**2**	**3**	**3**	**2**	**3**	**2**	**1**	**1**
MTT5304.3	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**1**	**2**
MTT5304.4	**2**	**2**	**1**	**2**	**2**	**2**	**3**	**1**	**1**
MTT5304.5	**3**	**2**	**2**	**3**	**3**	**3**	**2**	**2**	**2**
MTT5304.6	**3**	**2**	**1**	**3**	**2**	**2**	**2**	**1**	**2**

School: SSES		**Batch: 2025-27**
Programme: M.Sc.		**Academic Year: 2026-27**
Branch: Mathematics		**Semester: III**
1	Course Code	**MTP5358**
2	Course Title	Python Programming Lab
3	Credits	1
4	Contact Hours (L-T-P)	0-0-2
	Course Status	Compulsory
5	Course Objective	To develop Python Programs with Conditionals, Loops, and Functions: Enhance programming skills by implementing control structures and modular code design and effectively use lists, tuples, and dictionaries to represent and manipulate complex data. Also, to design and develop programs using classes and objects to model real-world scenarios.
6	Course Outcomes	CO1: Develop Python Programs to Solve Mathematical Problems: Demonstrate proficiency in writing Python code to address both simple and complex mathematical challenges..(K1, K2) CO2: Utilize Python's Data Structures Effectively: Apply and manipulate fundamental data structures such as lists, tuples, and dictionaries to represent and process mathematical data efficiently. (K2, K3) CO3: Implement Modular Programming Techniques: Design and use functions and modules to create organized, reusable, and maintainable code for mathematical computations. (K3, K4) CO4: Apply Object-Oriented Programming Principles: Develop Python programs using classes and objects to model complex mathematical structures and relationships. (K4, K5) CO5: Perform File Input and Output Operations: Read from and write to files to manage data pertinent to mathematical analyses and applications. (K5, K6) CO6: Visualize Mathematical Data: Create and interpret various data visualizations using Python libraries to effectively present mathematical findings and insights. .(K4, K6)
7	Course Description	This course is designed for postgraduate mathematics students to develop proficiency in Python programming for mathematical problem-solving and research. The course covers Python syntax, control structures, data structures, object-oriented programming, and the use of scientific libraries such as NumPy, SciPy, and SymPy. Students will engage in practical applications, including data analysis, visualization, and the development of algorithms to address complex mathematical challenges. This hands-on approach aims to equip students with the computational skills necessary for advanced mathematical modeling and research.
8	Outline syllabus		CO Mapping
	Unit 1	**Advanced Python Programming Concepts**	
		• In-depth exploration of Python's syntax and semantics • Advanced control structures and functions • Object-oriented programming: classes, inheritance, and polymorphism Exception handling and debugging techniques	CO1
	Unit 2	**Scientific Computing with Python**	
		• Utilizing NumPy for numerical operations and array manipulations • Applying SciPy for advanced mathematical functions and algorithms • Implementing linear algebra, optimization, and integration methods • Solving differential equations using Python libraries	CO2
	Unit 3	**Data Analysis and Visualization**	
		• Data manipulation with pandas: data frames, series, and indexing • Statistical analysis and hypothesis testing • Creating visualizations using Matplotlib and Seaborn • Interpreting and presenting data insights effectively	CO3
	Unit 4	**Symbolic Mathematics with SymPy**	
		• Performing algebraic computations symbolically • Simplifying expressions and solving equations analytically • Calculating limits, derivatives, and integrals symbolically Working with matrices and performing symbolic linear algebra	CO4

	Unit 5	**Applications in Mathematical Research**			
		• Developing algorithms for complex mathematical problems • Simulating mathematical models and systems • Implementing computational methods for research purposes • Conducting a project that applies Python to a specific area of mathematical research			CO5, CO6
	Mode of examination	Practical			
	Weightage Distribution	CA	CE	ETE	
		30 %	30 %	40 %	
	Text book				
	Other References				

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
MTP5358.1	**1**	**3**	**1**	**1**	**1**	**3**	**3**	**2**	**2**
MTP5358.2	**1**	**3**	**1**	**1**	**1**	**3**	**2**	**1**	**2**
MTP5358.3	**1**	**3**	**1**	**1**	**1**	**2**	**2**	**1**	**2**
MTP5358.4	**1**	**3**	**1**	**1**	**1**	**2**	**3**	**1**	**2**
MTP5358.5	**1**	**3**	**1**	**1**	**1**	**3**	**2**	**2**	**2**
MTP5358.6	**1**	**3**	**1**	**1**	**1**	**2**	**2**	**1**	**2**

DISSERTATION-I (MTR5353)

School: SSES		**Batch: 2025-27**	
Programme: M.Sc.		**Academic Year: 2026-27**	
Branch: Mathematics		**Semester: III**	
1	Course Code	MTR5353	
2	Course Title	DISSERTATION-I	
3	Credits	2	
4	Contact Hours (L-T-P)	0-0-4	
	Course Status	Compulsory/Elective	
5	Course Objective	• Develop advanced research skills in mathematical topics. • Learn to formulate a research problem, review literature, and apply appropriate methodologies. • Enhance technical writing and presentation skills for academic mathematics. • Produce an original dissertation under faculty supervision.	
6	Course Outcomes	CO1: Demonstrate the ability to independently investigate a specific mathematical topic, utilizing appropriate research methodologies and resources. (K2, K4) CO2: Construct and develop a deeper interest in mathematics and taste for research. (K5, K6) CO3: Select and recommend the activities that support their professional goals. (K4, K6) CO4: Develop effective project organizational skills. (K5) CO5. Discuss the ethical dimensions of your research and obtain appropriate ethical approval if needed. (K5) CO6. Plan a research article of the findings in an appropriate manner. (K6)	
7	Course Description	This course is designed to engage in independent research under academic supervision. This course allows students to delve deeply into a specific mathematical topic, culminating in a comprehensive dissertation that demonstrates their ability to conduct original research and effectively communicate their findings.	
8	Outline syllabus		CO Achievement
	Unit 1	**Research Problem Development** Selecting a research topic in pure/applied mathematics. Formulating research questions and objectives. Literature review techniques (using arXiv, MathSciNet, journals). Writing a research proposal (structure, significance, methodology).	**CO1**
	Unit 2	**Mathematical Research Methods** Theoretical vs. computational approaches. Tools: LaTeX, MATLAB, Mathematica, or Python for simulations. Proof techniques, modeling, and data analysis (if applicable).	**CO1,CO2**
	Unit 3	**Advanced Writing & Structuring** Dissertation structure (abstract, introduction, chapters, references). Mathematical writing conventions (theorems, proofs, notation). Avoiding plagiarism and proper citation (AMS, APA styles).	**CO2,CO3**
	Unit 4	**Independent Research & Supervision**Regular meetings with advisor. Progress reports and problem-solving sessions. Peer review and feedback.	**CO3, CO4**

	Unit 5	**Finalization & Presentation** Editing, proofreading, and formatting. Preparing a presentation/defense (slides, poster). Submission guidelines and evaluation criteria.			**CO5,CO6**
	Mode of examination	Jury/Practical/Viva			
	Weightage Distribution	CA	CE	ETE	
		30%	30%	40%	
	Text book/s*	-			
	Other References				

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
MTR5353.1	**3**	**3**	**2**	**2**	**2**	**3**	**2**	**3**	**3**
MTR5353.2	**2**	**3**	**3**	**2**	**3**	**2**	**3**	**3**	**2**
MTR5353.3	**2**	**3**	**2**	**2**	**3**	**3**	**3**	**3**	**3**
MTR5353.4	**2**	**3**	**2**	**2**	**2**	**3**	**2**	**3**	**2**
MTR5353.5	**2**	**2**	**2**	**3**	**3**	**3**	**3**	**3**	**3**
MTR5353.6	**2**	**2**	**2**	**3**	**3**	**3**	**3**	**3**	**3**

School: SSES		**Batch : 2025-26**	
Program: M.Sc.		**Current Academic Year: 2026-27**	
Branch: Mathematics		**Semester: III**	
1	Course Code	MTT5409	
2	**Course Title**	**Advanced Graph Theory and Information Security**	
3	Credits	**3**	
4	Contact Hours (L-T-P)	3-0-0	
	Course Status	Compulsory	
5	Course Objective	This course aims to introduce advanced concepts in **Graph Theory** and **Cryptography**, focusing on their applications in computer science, network security, and optimization problems. The course explores key algorithms in graph theory and modern cryptographic techniques for secure communication.	
6	Course Outcomes	CO1: Understand and apply fundamental graph theory concepts such as connectivity, shortest paths, and graph isomorphism. (K2,K4,K5) CO2: Implement spanning tree algorithms (Kruskal's, Prim's) and network flow methods for real-world problems. (K2,K4,K6) CO3: Explain the principles of cryptography, including classical ciphers, modular arithmetic, and number-theoretic foundations. (K1,K2,K6) CO4: Analyze advanced cryptographic techniques such as RSA, Diffie-Hellman key exchange, and elliptic curve cryptography. (K2,K6) CO5: Study the role of graph-based cryptographic algorithms and their applications in secure communications and blockchain. (K1, K2, K6) CO6: Explore quantum cryptography and its potential impact on classical cryptographic techniques. (K2,K4,K6)	
7	Course Description	This course covers essential topics in **Graph Theory and Cryptography**, focusing on their practical applications. Topics include **spanning trees, network flows, Hamiltonian graphs, shortest path algorithms**, and **modern cryptographic techniques such as RSA, ECC, and hash functions**. Applications in secure communication and computer networks are emphasized.	
8	Outline syllabus: **Advanced Graph Theory and Cryptographic Algorithms**		CO Mapping
	Unit 1	**Graph Theory Fundamentals**	

	A	Graphs, walks, Eulerian graphs, Hamiltonian graphs, isomorphism.			CO1
	B	Connectivity, shortest path algorithms (Dijkstra's, Floyd-Warshall).			CO1
	C	Planar graphs, Kuratowski's theorem, applications in network design.			CO1
	Unit 2	**Spanning Trees and Network Flows**			
	A	Spanning trees, Kruskal's and Prim's algorithms.			CO2
	B	Maximum flow and minimum cut theorem, Ford-Fulkerson algorithm.			CO2
	C	Graph-based models in optimization and transportation networks.			CO2
	Unit 3	**Introduction to Cryptography & INFORMATION SECURITY**			
	A	Security trends, The OSI Security Architecture, Security Attacks, Security Services and Security Mechanisms, A model for Network security.			CO3
	B	Symmetric Cipher Modes, Substitute Techniques,			CO3
	C	Transposition Techniques, Rotor Machines, Stenography.			CO3
	Unit 4	**BLOCK CIPHER ,** CONFIDENTIALITY AND MODULAR ARITHMETIC			
	A	Block Cipher Principles, Data Encryption Standards, the Strength of DES, Differential and Linear Crypt Analysis, Block Cipher Design Principles.			CO4
	B	Evaluation Criteria for AES, the AES Cipher.			CO5
	C	Prime Numbers, Fermat's and Euler's Theorem, Testing for Primality, The Chinese Remainder Theorem			CO5
	Unit 5	**Applications of Graph Theory in Cryptography**			
	A	Graph-based cryptographic protocols, Zero-Knowledge Proofs.			CO6
	B	Cryptographic applications in Blockchain and secure communications.			CO6
	C	Future trends in cryptography and graph theory applications.			CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		25%	25%	50%	

	Text book	2. B. West, Introduction to Graph Theory, Prentice Hall of India, 2001. 3. **J.A. Bondy and U.S.R. Murty**, "Graph Theory with Applications", Springer, 2008. 4. **Douglas Stinson**, "Cryptography: Theory and Practice", CRC Press, 2021.	
	Other References	1. J. A. Bondy and U. S. R. Murty, Graph Theory with Applications, Springer-Verlag, 2008. 2. R. Diestel, Introduction to Graph Theory, Springer-Verlag, 2010. 3. **William Stallings**, "Cryptography and Network Security", Pearson Education, 2017.	

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
MTT5409.1	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**1**
MTT5409.2	**3**	**2**	**3**	**3**	**2**	**3**	**2**	**1**	**2**
MTT5409.3	**2**	**2**	**3**	**2**	**3**	**2**	**2**	**1**	**2**
MTT5409.4	**2**	**3**	**2**	**2**	**2**	**2**	**3**	**3**	**2**
MTT5409.5	**3**	**2**	**2**	**3**	**2**	**3**	**2**	**2**	**2**
MTT5409.6	**3**	**2**	**2**	**3**	**2**	**2**	**2**	**2**	**2**

MEASURE THEORY(MTT5407)

School: SSES		**Batch: 2025-27**	
Programme: M.Sc.		**Academic Year: 2025-26**	
Branch: Mathematics		**Semester: IV**	
1	Course Code	MTT5407	
2	Course Title	MEASURE THEORY	
3	Credits	5	
4	Contact Hours (L-T-P)	5-0-0	
	Course Status	Compulsory	
5	Course Objective	This course provides an introduction to topics involving concepts of Topological space, σ-algebra of measurable sets, Borel sets, measurable functions, Lebesgue measure, integration of complex functions and linear functional.	
6	Course Outcomes	CO1: Explain the concept of Topological spaces, σ-algebra of measurable sets, Borel sets, Cantor ternary set. (K2, K3, K4) CO2: Describe the concept of Lebesgue outer measure, Lebesgue measure of Cantor ternary set, measurable functions, limsup and liminf of sequence of functions. (K1, K2, K5) CO3: Discuss the functions of Bounded Variation, Lebesgue's Differentiation Theorem. (K1, K2) CO4: Discuss Integration of measurable functions, Fatou's lemma, Lebesgue's monotone convergence theorem, Lebesgue's dominated convergence theorem (K2, K4, K6) CO5: Explain the L^P spaces, the inequalities of Holder and Minkowski, Completeness of $L^P(\mu)$.. (K2, K3, K4, K6) CO6: Describe the concept locally compactness and Hausdorff spaces, locally compact Hausdorff spaces, Urysohn's lemma, Riesz representation theorem. (K1, K2, K6)	
7	Course Description	This course provides an introduction to topics involving concepts of Topological space and separate axioms, σ-algebra of measurable sets, Borel sets, measurable functions, Lebesgue measure, integration of complex functions and linear functional. The primary objective of the course is to develop the advance understanding of Measure Theory.	
8	Outline syllabus		CO Mapping
	Unit 1	Preliminaries:	
	A	Topological spaces, continuous functions	CO1
	B	σ-algebra of measurable sets, Borel sets	CO1

	C	F_σ and G_δ sets, Cantor set, Cantor ternary set			CO1
	Unit 2	Lebesgue measure:			
	A	Lebesgue outer measure, Lebesgue measure of Cantor ternary set.			CO2
	B	measurable functions, limsup and liminf of sequence of functions.			CO2
	C	Approximation of measurable functions by simple functions, positive measures.			CO2
	Unit 3	**Differentiation**			
	A	The four derivatives, Continuous Non-differentiable functions,			CO3
	B	Functions of Bounded Variation			CO3, CO4
	C	Lebesgue's Differentiation Theorem, Differentiation and Integration.			CO3, CO4
	Unit 4	**Integration of functions of a real variable**			
	A	Integration of simple positive functions, Integration of measurable functions			CO5
	B	Fatou's lemma, Lebesgue's monotone convergence theorem			CO5
	C	Lebesgue's dominated convergence theorem, role of sets of measure zero.			CO5
	Unit 5	**Inequalities and the L^P Spaces**			
	A	The L^P spaces, The inequalities of Holder and Minkowski, Completeness of $L^P(\mu)$.			CO6
	B	Definition of compactness and Hausdorff spaces, Locally compact Hausdorff spaces.			CO6
	C	Urysohn's lemma, Riesz representation theorem.			CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		25%	25%	50%	
	Text book/s*	1) Walter Rudin: Real and Complex analysis, Mc GRAW HILL, International student edition.			
	Other References	1.Walter Rudin: Real and Complex analysis, Mc GRAW HILL, International student edition. 2.Walter Rudin: Principles of Mathematical analysis, Mc GRAW HILL, International series in Pure and Applies Mathematics. 3. H. L. Royden: Real Analysis, Amazon. Com.			

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
MTT5407.1	3	3	3	3	3	3	3	2	1
MTT5407.2	3	2	3	3	2	3	2	1	1
MTT5407.3	2	2	2	2	2	2	2	1	1
MTT5407.4	2	2	1	2	2	2	3	1	1
MTT5407.5	3	2	2	3	3	3	2	2	2
MTT5407.6	3	2	1	3	2	3	2	2	2

School: SSES		**Batch: 2025-27**
Program: M.Sc.		**Current Academic Year: 2026-27**
Branch: Mathematics		**Semester: IV**
1	Course Code	MTP5460
2	Course Title	Graph Theory Lab
3	Credits	1
4	Contact Hours (L-T-P)	0-0-2
	Course Status	Compulsory
5	Course Objective	The objective of this lab is to give students hands-on experience with the practical aspects of Graph Theory, enhancing their problem-solving skills, algorithmic thinking, and understanding of secure communication.
6	Course Outcomes	CO1: Implement and analyze various graph representations and algorithms. (K2, K3, K5) CO2: Understand and implement Dijkstra's Algorithm. (K2, K3, K6) CO3: Apply graph theory concepts in real-world problem-solving. (K2, K4, K6) CO4: Implement Eulerian and Hamiltonian circuits (K3, K4, K6) CO5: Develop Non planner graphs. (K2, K4, K6)
7	Course Description	This laboratory course provides students with hands-on experience in Graph Theory, focusing on their practical applications in real-world problem-solving. Through algorithmic implementation and computational tools like MATLAB, Python, C+, and JAVA, students will explore graph representations, traversal techniques, shortest path algorithms. The course enhances students' problem-solving abilities, algorithmic thinking, and understanding of secure communication.
8	Outline syllabus		CO Mapping
	Unit 1	**Graph Representation**	
		Write programs to represent a graph using: - Adjacency Matrix - Adjacency List	CO1
	Unit 2	**Graph Traversal Techniques** Implement Depth-First Search (DFS) and Breadth-First Search (BFS). Minimum Spanning Tree: Implement Prim's and Kruskal's algorithms.	CO2
	Unit 3	**Shortest Path Algorithms:**	CO3

		Implement Dijkstra's Algorithm and/or Bellman-Ford Algorithm.			
	Unit 4	**Eulerian graphs and Hamiltonian graphs** Write a program to Eulerian and Hamiltonian circuits.			CO4
	Unit 5	**Classification of regular polytopes** Kuratowski's theorem for non-planner graph			CO5
	Mode of examination	Practical &Viva			
	Weightage Distribution	CA	CE	ETE	
		30%	30%	40%	
	Text book	1. **Graph Theory with Applications** by Narsingh Deo 2. **Introduction to Graph Theory** by Douglas B. West			
	Other References	Getting started with Matlab: RudraPratap MATLAB / Python (SciPy, NumPy, PuLP) Python / C / C++ / Java programming environment			

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
MTP5460.1	**3**	**3**	**2**	**2**	**2**	**3**	**2**	**2**	**3**
MTP5460.2	**2**	**3**	**3**	**3**	**3**	**2**	**3**	**3**	**2**
MTP5460.3	**2**	**3**	**2**	**2**	**3**	**3**	**3**	**3**	**3**
MTP5460.4	**2**	**3**	**2**	**3**	**2**	**2**	**2**	**3**	**2**
MTP5460.5	**3**	**3**	**2**	**3**	**2**	**2**	**3**	**2**	**3**
MTP5460.5	**3**	**2**	**1**	**3**	**2**	**3**	**2**	**2**	**2**

DISSERTATION-2 (MTR5456)

School: SSES		**Batch: 2025-27**	
Programme: M.Sc.		**Academic Year: 2025-26**	
Branch: Mathematics		**Semester: IV**	
1	Course Code	MTR5456	
2	Course Title	DISSERTATION-2	
3	Credits	3	
4	Contact Hours (L-T-P)	0-0-6	
	Course Status	Compulsory/Elective	
5	Course Objective	• Finalize and polish a near-complete dissertation. • Strengthen rigor, clarity, and academic presentation. • Prepare for a successful defense/publication.	
6	Course Outcomes	CO1: Explain the concept of research within the subject, as regards approaching a question, collecting and analysing background material and presenting research questions and conclusions. (K2, K4) CO2: Construct and develop a deeper interest in mathematics and taste for research. (K5, K6) CO3: Select and recommend the activities that support their professional goals. (K4, K6) CO4**:** Develop effective project organizational skills. (K5) CO5. Discuss the ethical dimensions of your research and obtain appropriate ethical approval if needed. (K5) CO6. Plan a research article of the findings in an appropriate manner. (K6)	
7	Course Description	This course is the culmination of the postgraduate mathematics program, guiding students through the process of conducting original and substantial research. Students will formulate complex mathematical problems, engage deeply with existing literature, develop and apply advanced methodologies, analyze results rigorously, and present their findings in a scholarly dissertation.	
8	Outline syllabus		CO Achievement
	Unit 1	**Dissertation Refinement** Structural edits (logical flow, theorem-proof consistency). Notation standardization and LaTeX troubleshooting. Peer/external feedback integration.	**CO1**
	Unit 2	**Technical Deep Dive** Resolving open lemmas/proof gaps. Cross-validating results (examples/counterexamples). Advisor-led problem-solving sessions.	**CO1,CO2**
	Unit 3	**Writing & Citations**Abstract, introduction, conclusion polishing. AMS/APA citation compliance. Plagiarism checks (Turnitin/iThenticate).	**CO2,CO3**
	Unit 4	**Defense Preparation** Creating slides/posters (Beamer/PPT). Mock Q&A sessions with advisors. Time management for 30–45 min presentations.	**CO3, CO4**
	Unit 5	**Submission & Closure** Formatting per university guidelines. E-submission procedures. Post-defense revisions (if required).	**CO5,CO6**
	Mode of examination	Jury/Practical/Viva	

	Weightage Distribution	CA	CE	ETE	
		30%	30%	40%	
	Text book/s*	-			
	Other References				

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
MTR5456.1	**3**	**3**	**2**	**2**	**2**	**3**	**2**	**3**	**3**
MTR5456.2	**2**	**3**	**3**	**2**	**3**	**2**	**3**	**3**	**2**
MTR5456.3	**2**	**3**	**2**	**2**	**3**	**3**	**3**	**3**	**3**
MTR5456.4	**2**	**3**	**2**	**2**	**2**	**3**	**2**	**3**	**2**
MTR5456.5	**2**	**2**	**2**	**3**	**3**	**3**	**3**	**3**	**3**
MTR5456.6	**2**	**2**	**2**	**3**	**3**	**3**	**3**	**3**	**3**

LINEAR PROGRAMMING (MTT5305)

School: SSES		**Batch :2025-27**	
Programme: M.Sc.		**Academic Year: 2026-27**	
Branch: Mathematics		**Semester: IV**	
1	Course Code	MTT5305	
2	Course Title	LINEAR PROGRAMMING	
3	Credits	3	
4	Contact Hours (L-T-P)	3-0-0	
	Course Status	Compulsory	
5	Course Objective	To make students familiar with the concepts of simple analytical Methods to solve L.P.P., queuing theory with kendall's notations, inventory control with ABC analysis, Project Management (CPM & PERT).	
6	Course Outcomes	CO1: Discuss the origins of Operation Research, formulate the problems in L.P. and solve it by graphical. (K1, K3, K6) CO2: Explain analytical Methods: Simplex, Big M, Primal and Dual problems and discuss about economic interpretation of dual. (K2,K3, K4) CO3: Describe queuing theory and Kendall's Notations and formulate M/M/1:∞/FCFS model illustrate with example. (K2, K3, K6) CO4: Explain inventory classifications and develop economic order quantity models. (K2, K4, K6) CO5: Explain ABC analysis. (K2,K4) CO6: Describe the concept of CPM and PERT and calculate float calculation and Cost reduction by Crashing of activities. (K1, K2,K3)	
7	Course Description	This course is an introduction to concept of linear Programmeming problems. The primary objective of the course is to develop the understanding of queuing theory with kendall's notations, inventory control with ABC analysis, Project Management (CPM & PERT).	
8	Outline syllabus		CO Mapping
	Unit 1	**Origin of Operation Research**	
	A	Origin of Operation Research, Historical Standpoint, Methodology, Different Phases.	CO1
	B	Characteristics, Scope and Application of Operations Research. Introduction.	CO1
	C	Requirement of LP, Basic Assumptions, Formulation of LP, General Statement of LP, Solution techniques of LP: Graphical Methods.	CO1
	Unit 2	**Analytical Methods**	
	A	Solution of problem using analytical Methods: Simplex.	CO2
	B	Big M, Primal and Dual Problems.	CO2
	C	Economic Interpretation and Dual Simplex Method.	CO2
	Unit 3	**Queuing Theory**	
	A	Fundamentals of queuing theory and its key elements.	CO3
	B	Operating characteristics of a queuing system and the classification of different queuing models.	CO3
	C	Preliminary examples of M/M/1:∞/FCFS.	CO3
	Unit 4	**Inventory Control**	

	A	Inventory classification, Different cost associated to Inventory.			CO4
	B	Economic order quantity, Inventory models with deterministic demands			CO4
	C	ABC analysis.			CO4, CO5
	Unit 5	**Project Management**			
	A	Introduction to PERT and CPM, including critical path calculation.			CO6
	B	Float calculation and its significance in project management.			CO6
	C	Cost reduction through the crashing of activities.			CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		25%	25%	50%	
	Text book/s*	3. Taha, H.A., Operations Research-An introduction, New York: MacMillan, 1992. 4. KantiSwarup, P. K. Gupta and Man Mohan: Operation Research ; S. Chand & Sons, New delhi.			
	Other References	3. Hadley, G., Linear Programmeming, Addison –Wesley, 1962. 4. Hillier, F.S. and G.J. Lieberman, Introduction to Operations Research-concept and cases, Asian Ed., Tata McGraw-Hill.			

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
MTT5305.1	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**1**
MTT5305.2	**3**	**2**	**3**	**3**	**2**	**3**	**2**	**1**	**2**
MTT5305.3	**2**	**2**	**2**	**2**	**2**	**1**	**2**	**2**	**1**
MTT5305.4	**2**	**2**	**1**	**3**	**2**	**2**	**3**	**1**	**1**
MTT5305.5	**3**	**1**	**2**	**3**	**2**	**3**	**2**	**2**	**2**
MTT5305.6	**3**	**2**	**1**	**3**	**2**	**2**	**2**	**1**	**1**

DISSERTATION-I (MTR5354)

School: SSES		**Batch: 2025-27**	
Programme: M.Sc.		**Academic Year: 2026-27**	
Branch: Mathematics		**Semester: III**	
1	Course Code	MTR5354	
2	Course Title	DISSERTATION-I	
3	Credits	16	
4	Contact Hours (L-T-P)	0-0-32	
	Course Status	Compulsory/Elective	
5	Course Objective	• Conduct original, independent research in pure/applied mathematics. • Master advanced literature review, problem-solving, and technical writing. • Develop expertise in a specialized mathematical subfield. • Produce a publishable-quality dissertation (60–100 pages). • Defend research findings in a formal seminar/viva.	
6	Course Outcomes	CO1: Demonstrate the ability to undertake autonomous research in advanced mathematics, formulating and addressing complex problems. (K2, K4) CO2: Exhibit proficiency in reviewing and synthesizing current research literature relevant to the chosen mathematical topic. (K5, K6) CO3: Effectively utilize sophisticated mathematical theories and techniques to solve intricate problems within the scope of the dissertation. (K4, K6) CO4: Develop complex mathematical concepts and findings clearly and coherently in written form, adhering to academic standards. (K5) CO5. Discuss the ethical dimensions of your research and obtain appropriate ethical approval if needed. (K5) CO6. Plan a research article of the findings in an appropriate manner. (K6)	
7	Course Description	This course provide students with an opportunity to engage in substantial independent research within the field of mathematics. This module allows students to explore a specific mathematical topic in depth, demonstrating their ability to apply advanced concepts, conduct rigorous analysis, and contribute original insights to the discipline.	
8	Outline syllabus		CO Achievement
	Unit 1	**Topic Finalization & Literature Survey**Refining research questions (originality/gap analysis). Advanced literature review using MathSciNet, arXiv, ZbMATH. Critical analysis of existing theorems/methods.	**CO1**
	Unit 2	**Methodology & Theoretical Framework** Proof techniques (e.g., analytic, combinatorial, geometric).Computational tools (MATLAB, SageMath, Python for simulations).Analytical/numerical modeling (if applicable).	**CO1,CO2**
	Unit 3	**Research Execution** Intensive problem-solving and derivations. Weekly meetings with adviser for feedback. Peer discussions/collaborations (if interdisciplinary).	**CO2,CO3**

	Unit 4	**Writing & Refinement** Structuring the dissertation (AMS/Latex templates). Writing proofs, lemmas, and theorems rigorously. Incorporating adviser feedback iteratively.			**CO3, CO4**
	Unit 5	**Finalization & Defense** Polishing arguments, formatting, and citations. Preparing a 45-minute defense seminar. Addressing reviewer feedback (if applicable).			**CO5,CO6**
	Mode of examination	Jury/Practical/Viva			
	Weightage Distribution	CA	CE	ETE	
		30%	30%	40%	
	Text book/s*	-			
	Other References				

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
MTR5354.1	**3**	**3**	**2**	**2**	**2**	**3**	**2**	**3**	**3**
MTR5354.2	**2**	**3**	**3**	**2**	**3**	**2**	**3**	**3**	**2**
MTR5354.3	**2**	**3**	**2**	**2**	**3**	**3**	**3**	**3**	**3**
MTR5354.4	**2**	**3**	**2**	**2**	**2**	**3**	**2**	**3**	**2**
MTR5354.5	**2**	**2**	**2**	**3**	**3**	**3**	**3**	**3**	**3**
MTR5354.6	**2**	**2**	**2**	**3**	**3**	**3**	**3**	**3**	**3**

DISSERTATION-2 (MTR5457)

School: SSES		**Batch: 2025-27**	
Programme: M.Sc.		**Academic Year: 2025-26**	
Branch: Mathematics		**Semester: IV**	
1	Course Code	MTR5457	
2	Course Title	DISSERTATION-2	
3	Credits	16	
4	Contact Hours (L-T-P)	0-0-32	
	Course Status	Compulsory/Elective	
5	Course Objective	• Deep knowledge of a specific area of specialization. • Develop communication skills especially in project writing and oral presentation. Develop some time management skills.	
6	Course Outcomes	CO1: Explain the concept of research within the subject, as regards approaching a question, collecting and analysing background material and presenting research questions and conclusions. (K2, K4) CO2: Construct and develop a deeper interest in mathematics and taste for research. (K5, K6) CO3: Select and recommend the activities that support their professional goals. (K4, K6) CO4**:** Develop effective project organizational skills. (K5) CO5. Discuss the ethical dimensions of your research and obtain appropriate ethical approval if needed. (K5) CO6. Plan a research article of the findings in an appropriate manner. (K6)	
7	Course Description	This course is the culmination of the postgraduate mathematics program, guiding students through the process of conducting original and substantial research. Students will formulate complex mathematical problems, engage deeply with existing literature, develop and apply advanced methodologies, analyze results rigorously, and present their findings in a scholarly dissertation.	
8	Outline syllabus		CO Achievement
	Unit 1	**Research Finalization & Gap Resolution** Completing all pending theoretical proofs/derivations Resolving open problems identified in Semester 3 Final computational experiments/numerical validation	**CO1**
	Unit 2	**Dissertation Writing & Structuring** Optimal organization of chapters (theory-first vs results-first) Writing mathematical narratives (theorem-proof-exposition balance) Handling special cases and counterexamples	**CO1,CO2**
	Unit 3	**Peer Review & Iterative Refinement** Formal peer review among cohort External review by domain specialist Three-round revision system	**CO2,CO3**
	Unit 4	**Publication Preparation** Journal article extraction (AMS style) Conference proceedings adaptation arXiv pre-print optimization	**CO3, CO4**
	Unit 5	**Defense & Dissemination** Preparation: 45-minute seminar drill (3 dry runs) Anticipatory Q&A database Blackboard handling techniques Public Engagement: Departmental colloquium presentation 3MT (Three Minute Thesis) adaptation	**CO5,CO6**

		Open Science Framework deposition			
	Mode of examination	Jury/Practical/Viva			
	Weightage Distribution	CA	CE	ETE	
		30%	30%	40%	
	Text book/s*	-			
	Other References				

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
MTR5457.1	**3**	**3**	**2**	**2**	**2**	**3**	**2**	**3**	**3**
MTR5457.2	**2**	**3**	**3**	**2**	**3**	**2**	**3**	**3**	**2**
MTR5457.3	**2**	**3**	**2**	**2**	**3**	**3**	**3**	**3**	**3**
MTR5457.4	**2**	**3**	**2**	**2**	**2**	**3**	**2**	**3**	**2**
MTR5457.5	**2**	**2**	**2**	**3**	**3**	**3**	**3**	**3**	**3**
MTR5457.6	**2**	**2**	**2**	**3**	**3**	**3**	**3**	**3**	**3**