Programme and Course Structure

Sharda School of Basic Science and Research
Department of Mathematics

B.Sc. (Hons./ Hons. With Research) Mathematics

Programme Code: SBR0302

Batch 2024-28

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

M1. Transformative educational experience.
M2. Enrichment of educational initiatives that encourage global outlook.
M3. Develop research, support disruptive innovations, and accelerate entrepreneurship.
M4. Seeking beyond boundaries.
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Core Values

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

Vision and Mission of School

Vision of the School

Achieving excellence in the realm of science to address the challenges of evolving society.

Mission of the School

1. Equip the students with knowledge and skills.
2. Capacity building by providing academic flexibility to student and Faculty members.
3. To establish center of excellence for innovative research.
4. Address the deficiencies of the society pertaining to environment
5. To strengthen academic- industry collaboration for better. Employability.
6. Developing a culture for continued betterment in all facets of life.

Core Values

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

Vision and Mission of the Department of Mathematics

Vision of the Department

To become a globally recognized destination for education in applied mathematics 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 to serve the society at large.
3. To develop skills for the applications of mathematics in the various fields.

Core Values

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

B. Sc. (Hons. / Hons. With Research) Mathematics

Programme Educational Objectives (PEOs)

PEO1. Provide a solid foundation in mathematics, give a flavour of some very advanced modern branches of mathematics, and develop interdisciplinary skills.

PEO2. Develop critical thinking, creative thinking, and self-confidence for eventual success in career

PEO3. To prepare the students to communicate mathematical ideas effectively and develop their ability to collaborate both intellectually and creatively in diverse contexts.

PEO4. Rewarding careers in private and government sectors such as Education, Industry, Banks, MNCs, and pursue higher studies.

Programme Outcomes

The graduates should be able to demonstrate the capability to

PO1. Complex Problem Solving: Solve different kinds of problems in familiar and non-familiar contexts and apply the learning to real-life situations.

PO2. Critical Thinking: Analyze and synthesize data from a variety of sources and draw valid conclusions and support them with evidence and examples.

PO3. Creativity: Demonstrate the ability to think 'out of the box' and generate solutions to complex problems in unfamiliar contexts by applying concepts of multidisciplinary and interdisciplinary.

PO4. Analytical reasoning/thinking: Evaluate the reliability and relevance of evidence.

PO5. Research-related skills: Demonstrate the ability to acquire the understanding of basic research ethics and skills in practicing/doing ethics in the field/ in personal research work, regardless of the funding authority or field of study.

PO6. Communication Skills: Demonstrate the skills that enable them to express thoughts and ideas effectively in writing and orally and communicate with others using appropriate media.

PO7. Coordinating/collaborating with others: Demonstrate the ability to work effectively and respectfully with diverse teams using management skills to guide people to the right destination.

PO8. Digital and technological skills: Demonstrate the capability to access, evaluate, and use a variety of relevant information sources, and use appropriate software for analysis of data.

PO9. Value Inculcation: Instill integrity and identify ethical issues related to work, and follow ethical practices with or understand the perspective, experiences, or points of view of another individual or group, and to identify and understand other people's emotions.

PO10. Sustainability Growth: Demonstrate the capability to lead a diverse team or individual to accomplish and participate in community-engaged services/ activities for promoting the well-being of society to mitigating the effects of environmental degradation, climate change, and pollution.

PO11. Multidisciplinary Life-long learning: Comprehensive knowledge and coherent understanding of the chosen disciplinary/interdisciplinary areas of study in a broad multidisciplinary context by inculcating a healthy attitude to be a lifelong learner.

Programme Specific Outcomes of B.Sc. (Hons. / Hons. With Research) Mathematics

PSO1. Select and use appropriate mathematical formulae or techniques in order to process the information and draw the relevant conclusion.

PSO2. Develop the ability to reflect on problems that are quite significant in the field of pure mathematics.

PSO3. Apply programming knowledge gained from MATLAB, Python, R, Excel through applied mathematics, and statistics as per the need of industry.

Mapping of PEOs with Mission Statements

PEO Statements	School Mission1	School Mission2	School Mission3	School Mission4	School Mission5	School Mission6
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

Mapping of Programme Outcomes Vs Programme Educational Objectives

	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**
PO6	**3**	**3**	**3**	**2**
PO7	**1**	**2**	**1**	**3**
PO8	**2**	**2**	**1**	**3**
PO9	**2**	**2**	**2**	**3**
PO10	**2**	**2**	**2**	**3**
PO11	**3**	**2**	**2**	**1**
PSO1	**3**	**3**	**2**	**2**
PSO2	**2**	**3**	**1**	**2**
PSO3	**3**	**2**	**3**	**2**

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

Structure of FY UG Programme

The Semester wise and Broad Course Category-wise distribution of credits of the Undergraduate Programme

Semester	Discipline Core Major (60/80 Credits)	Minor (24/32 Credits)	Inter/Multi - disciplinary courses (09 Credits)	Ability Enhancement courses (AEC) (08 Credits)	Skill Enhancement Courses (SEC) (09 Credits)	Common Value Added Courses (06-08 Credits)	Summer Internship (02-04 Credits)	Research	Total Credits (120/160)	
I	Th-1(2)+Pract-1(2) or Th-1(3) + Pract-1(1) & Th-1(4) [8]	1(3) [3]	1(2) [2]	ARP(2) [2]	1(3) [3]	VAC1 (2) [2]			40	First Minor Core is fixed course for each school. VAC Courses include -Environment -Indian Knowledge System -Mulya Pravah VAC/SEC/Multidis/AEC can be taken from NPTEL
II	Th-1(2)+Pract-1(2) or Th-1(3) + Pract-1(1) & Th-1(4) [8]	1 (3) [3]		ARP(2) [2]	1(3) [3]	VAC2 (2) VAC3 (2) [4]				
	Students exit the programme after securing 40 credits will be awarded UG certificate in the relevant Discipline / Subject provided they secure 4 credits in work based vocational courses offered during summer term or internship / Apprenticeship in addition to 6 credit from skill - based courses earned during first and second									
III	Th-1(3)+Pract-1(2) or Th-1(4) + Pract-1(1) & Th-1(5) [10]	1(3) [3]	1(2) [2]	Th-1(2) Indian Language [2]	1(3) [3]			RBL1 -1(0) [0]	80	**Consent to be taken from Students for Apprenticeship by floating name of Industries Mandatory visit to Abhivyakti Wellness Clinic as Audit Course to be taken in any semester (Except 1st & final sem.)
IV	Th-2(3)+Pract-2(2) or Th-2(4) + Pract-1(2) & Th-1(4) [14]	1(3) [3]		Community Connect-1(2) [2]				RBL2 -1(1) [1]		
	Students exit the programme after securing 80 credits will be awarded UG Diploma in the relevant Discipline / Subject provided they secure additional 4 credits in skill based vocational courses offered during first year or second year summer term or Internship									
V	Th-2(4) & Th-3(3)+Pract-3(1) or Th-4(4) + Pract-2(2) [20]							RBL3 -1(0) (Audit) [0]	120	3- Year UG Degree inclusive of optional Apprenticeship
VI		3(4) [12]	1(3) [3] or Th-1(2) + Pract-1(1)	ARP (2)/Foeign Language(2) [2]			Industry Connect-1(2)/ Summer Internship-1(2) [2]	RBL4 -1(1) [1]		
OR VI	****APPRENTICESHIP [20]**								20	
	Students who want to undertake 3-year UG programme will be awarded UG Degree in the relevant Discipline / Subject upon securing 120 credits									
VII	Th-4(4)+Pract-4(1) or Th-4(4) or Th-4(4) + Pract-2(2) [20]	1(4)* [4]							160	***ONLY for students going for Apprenticeship & requires Minor with Major Degree** 4- Year UG Degree (Honours) inclusive of optional Apprenticeship
VIII		2(4) [8]	Th-2(4) or Th-2(3)+Pract-2(1) [8]					Project (4) [4]		
OR VIII	****APPRENTICESHIP [20]**								20	
	OR									
VII	Th-3(4)+Pract-4(1) or Th-4(4) or Th-3(4) + Pract-2(2) [16]	1(4) [4]						Research Project - (12) **03 Credits** evaluation will be done in VII Semester & **09 Credits**	160	4- Year UG Degree (Honours with Research)
VIII	Th-1(3) + Pract-1(1) or Th-1(2) + Pract-1(2) [4]	1(4) [4]								
	Students wil be awarded UG Degree (Honours) with Research in the relevant Discipline / Subject provided they secure min. 160 credits									

Structure of UG Programme(Mathematics)

Table 3: The Semester wise and Broad Course Category-wise distribution of credits of the Undergraduate Programme:

Semester	Discipline Core Major (60/80 Credits)	Minor (24/32 Credits)	Inter/Multi - disciplinary courses (09 Credits)	Ability Enhancement courses (AEC) (08 Credits)	Skill Enhancement Courses (SEC) (09 Credits)	Common Value Added Courses (V A C) (0 6-08 Credits)	Summer Internship (02-04 Credits)	Research Project (12 Credits)	Total Credits (120/160)	
I	MSM101 **(4)** & CMS151(1) [5]	CMS102**(3)** [3]	CSE113(3)& CSP113(1) [4]	ARP101**(2)** [2]	VOM103**(3)** [3]	VAC103(3) [3]			40	First Minor Core is a fixed course for each school.
II	CMS131(4)+ CMS171(1)+ CSE242(3)+ CSP242(1) [9]	CMS132**(3)** [3]		ARP102**(2)** [2]	VOM104**(3)** [3]	VAC110**(3)** [3]				
	Students existing the programme after securing 40 credits will be awarded UG certificate in the relevant Discipline / Subject provided they secure 4 credits in work based vocational courses offered during summer term or internship / Apprenticeship in addition to 6 credit from skill - based courses earned during first and second									VAC/SEC/Multidis/AEC can be taken from NPTEL
III	CMS202**(3)** + CMS251**(2)** & CMS201**(5)** [10]	BDA215**(3)** [3]	AI3407 **(2)** [2]	Th-1(2) Indian Language [2]	VOM2305**(3)** [3]			MTR2351 [0]	80	Mandatory visit to Abhivyakti Wellness Clinic as Audit Course to be taken in any semester (Except 1st & final sem.)
IV	CMS231**(4)** + CMS232**(4)**+ MTP2451**(2)**+ MSM306**(4)** [14]	AI3408 **(3)** [3]		CCU108**(2)** [2]				MTR2452 [1]		On VAC Courses -Environment -Indian Knowledge System -Mulya Pravah
	Students existing the programme after securing 80 credits will be awarded UG Diploma in the relevant Discipline / Subject provided they secure additional 4 credits in skill based vocational courses offered during first year or second year summer term or Internship									
V	MSM301**(4)**+CMS302**(4)** +CMS332**(4)** + CMS331**(4)** +MTP3551**(2)**+MTP3552**(2)**							MTR3551 (Audit)	120	

		[20]						[0]		
VI		CMS433**(4)** + MSM312 (4) + AI3409**(4)** [12]	MTT3601(3) [3]	ARP306**(2)** Foeign-Language(2) [2]			INC001 (2) [2]	MTR3652 [1]		{80+40=120} 3- Year UG Degree with single major or major with minor
OR **VI**			**Apprenticeship [20]**					RBL4 -1(0) (Audit) [0]	20	{120}
	OR									
VII	CMS403**(4)**+ MTT4703**(4)**+ STT4704 **(4)**+ MMT209**(3)**+ MMT151 **(2)**+ MMT152**(2)**+ MDA156(1) [20]	**** (MMT209) NA(4)** [4]							160	*Should be taken if not going to internship {120+40=160} 4- Year UG Degree (Honours) {160} Bachelor (Honours) in Faculty with single major
VIII		MMT203(4)+MMT107(4) [8]	MDA110(3)+CMS401(3)+MDA155(1)+CMS451(1) [8]					MTR4854 **(4)**		
	OR									
VII	MTT4703(4)+STT4704(4)+MMT209(3)+MMT151(2)+MMT152(2)+MDA156(1) [16]	MMT108(4) [4]						**MTR4755(3)** **[3]**		
VIII	MMT205(4) **[4]**	MMT202(4) [4]						**MTR456(9)** **[9]**		

Programme Structure Template

B. Sc. (Hons. / Hons. With Research) Mathematics **Batch: 2024-28**

TERM: 2401 (Semester-I)

S. No.	Course Code	Course Name	Teaching Load				Credits	Pre-Requisite/ Co-Requisite	Type of Course: 1. CC; 2. DSE; 3. OPE; 4. SEC; 5. AEC; 6. VAC; 7.Project
	THEORY		**L**	**T**	**P**	**TOTAL (hrs)**			
1.	MSM101	Foundation Course in Mathematics	4	0	0	4	4	Basic Mathematics upto 10+2	CC Major
2.	CSE113	Programming for Problem Solving	2	0	0	2	2(was 3)		DSE
3.	CMS102	Descriptive Statistics	3	0	0	3	3	Basic Mathematics upto 10+2	Minor
4.	VAC103	Environmental Education	2	0	0	2	2		VAC1
	PRACTICALS								
5.	CSP113	Programming for Problem Solving LAb	3	0	0	3	3		CC
6.	ARP101	Communicative English-1	1	0	2	3	2		AEC
7.	CMS151	Foundation course in mathematics Lab	0	0	2	2	1		CC
8.	VOM103	Essential Excel Skills for Business	0	0	6	6	3		SEC
TOTAL CREDITS							**20**		

Programme Structure Template

B. Sc. (Hons./ Hons. With Research) Mathematics **Batch: 2024-28**

TERM: 2402 (Semester-II)

S. No.	Course Code	Course Name	Teaching Load				Credits	Pre-Requisite/ Co-Requisite	Type of Course: 1. CC; 2. DSE; 3. OPE; 4. SEC; 5. AEC; 6. VAC; 7.Project
	THEORY		**L**	**T**	**P**	**TOTAL (hrs)**			
1.	CMS131	Matrix Analysis and Linear Algebra	4	0	0	4	4	Pre-requisite MSM101	CC
2.	CSE242	Data Structures	3	0	0	3	3		CC
3.	CMS132	Mathematical Expectations & Probability Distributions	3	0	0	3	3		OPE Minor
4.	VAS	Value added course	3	0	0	3	0		
	PRACTICALS								
5.	VAC110	Yoga for Holistic Health	0	1	4	5	3		VAC
6	CMS171	Matrix Analysis & Linear Algebra Lab	0	0	2	2	1		CC
7.	CSP242	Data Structure Lab	0	0	2	2	1		CC
8.	ARP102	Communicative English-2	1	0	2	3	2		AEC
9.	VOM104	Advanced Excel Skills for Business	0	0	6	6	3	Pre-requisite VOM103	SEC
TOTAL CREDITS							**20**		

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Programme Structure Template

B. Sc. (Hons./ Hons. With Research) Mathematics **Batch: 2024-28**

TERM: 2501 (Semester-III)

S. No.	Course Code	Course Name	Teaching Load				Credits	Pre-Requisite/ Co-Requisite	Type of Course: 1. CC; 2. DSE; 3. Minor; 4. SEC; 5. AEC; 6. VAC; 7.Project
	THEORY		**L**	**T**	**P**	**TOTAL (hrs)**			
1.	CMS201	Abstract Algebra	5	0	0	5	5		CC
2.	CMS202	Calculus	3	0	0	3	3		CC
3.	BDA215	Operation Research	3	0	0	3	3		Minor
4.	XXX	Indian Language	2	0	0	2	2		AEC
	PRACTICALS								
5.	AI3407	Prompt Engineering for AI and Data Science	0	0	4	4	2		DSE
6.	CMS251	Calculus Lab	0	0	4	4	2		CC
7.	VOM2305	Data Visualization with Tableau and Power BI	0	0	6	6	3		SEC
8.	MTR2351	Research Based Learning-I(RBL-1)	0	0	2	2	0		Research Project
TOTAL CREDITS							**20**		

Programme Structure Template

B. Sc. (Hons./ Hons. With Research) Mathematics **Batch: 2024-28**

TERM: 2502 (Semester-IV)

S. No.	Course Code	Course Name	Teaching Load				Credits	Pre-Requisite/ Co-Requisite	Type of Course: 1. CC; 2. DSE; 3. Minor; 4. SEC; 5. AEC; 6. VAC; 7. Project
	THEORY		**L**	**T**	**P**	**TOTAL (hrs)**			
1.	CMS231	Real Analysis	4	0	0	4	4		CC
2.	CMS232	Ordinary Differential Equations and Laplace Transforms	4	0	0	4	4		CC
3.	MSM306	Mechanics	4	0	0	4	4		CC
	Practicals								
5.	MTP2451	Ordinary Differential Equations and Laplace Transforms Lab	0	0	4	4	2		CC
6.	AI3408	Supervised & unsupervised Learning Techniques	0	0	6	6	3		Minor
7.	CCU108	Community Connect	0	0	4	4	2		AEC
8.	MTR2452	Research Based Learning-2(RBL-2)	0	0	2	2	1		Project
TOTAL CREDITS							**20**		

Programme Structure Template

B. Sc. (Hons./ Hons. With Research) Mathematics **Batch: 2024-28**

TERM: 2601 (Semester-V)

S. No.	Course Code	Course Name	Teaching Load				Credits	Pre-Requisite/ Co-Requisite	Type of Course: 1. CC; 2. DSE; 3. Minor; 4. SEC; 5. AEC; 6. VAC; 7.Project
	THEORY		**L**	**T**	**P**	**TOTAL (hrs.)**			
1.	MSM301	Complex Analysis	3	1	0	4	4	Pre-requisite CMS231	CC
2.	CMS302	Mathematical Modelling	4	0	0	4	4	Pre-requisite CMS232	CC
3.	CMS332	Introduction to Partial Differential Equations	4	0	0	4	4	Pre-requisite CMS232	CC
4.	CMS331	Numerical Methods	4	0	0	4	4	Pre-requisite CMS202, 231	CC
	Practical's								
5.	MTP3551	Introduction to Partial Differential Equations Lab	0	0	4	4	2	Co-requisite CMS332	CC
6.	MTP3552	Mathematical Modelling Lab	0	0	4	4	2	Co-requisite CMS302	CC
7.	MTR3551	Research Based Learning-III (RBL-3)	0	0	2	2	0	Pre-requisite RBL002	Project
TOTAL CREDITS							**20**		

Programme Structure Template

B. Sc. (Hons./ Hons. With Research) Mathematics **Batch: 2024-28**

TERM: 2602 (Semester-VI)

S. No.	Course Code	Course Name	Teaching Load				Credits	Pre-Requisite/ Co-Requisite	Type of Course: 1. CC; 2. DSE; 3. Minor; 4. SEC; 5. AEC; 6. VAC; 7.Project
	THEORY		**L**	**T**	**P**	**TOTAL (hrs)**			
1.	CMS433	Integral Equations & Calculus of Variations	4	0	0	4	4	Pre-requisite CMS131,202,232	Minor
2.	MSM312	Discrete Mathematics	3	1	0	4	4		Minor
4.	MTT3601	Metric Space	3	0	0	3	3		DSE
	Practicals								
5.	ARP306	Campus to Corporate	1	0	2	3	2	AEC	AEC
6.	AI3409	Advanced Machine Learning Techniques	0	0	8	8	4		Minor
7.	INC001	Industry Connect	0	0	4	4	2		Project
8.	MTR3652	Research Based Learning-IV (RBL-4)	0	0	2	2	1	Pre-requisite RBL003	Project
TOTAL CREDITS							**20**		

Programme Structure Template

B. Sc. (Hons./ Hons. With Research) Mathematics **Batch: 2024-28**

TERM: 2701 (Semester-VII)

S. No.	Course Code	Course Name	Teaching Load				Credits	Pre-Requisite/ Co-Requisite	Type of Course: 1. CC; 2. DSE; 3. Minor; 4. SEC; 5. AEC; 6. VAC; 7.Project
	THEORY		**L**	**T**	**P**	**TOTAL (hrs)**			
1.	CMS403	Number Theory	4	0	0	4	4	Pre-requisite MSM312	CC
2.	MTT4703	Introduction to MATLAB and its Applications	4	0	0	4	4	**CO-REQUISITE**	CC
3.	STT4704	Probability and Statistical Methods	4	0	0	4	4	**CO-REQUISITE**	CC
4.	MMT 209	Econometrics	3	0	0	3	3	**CO-REQUISITE**	CC
	Practicals								
5.	MMT 151	Mathematics Lab- I	0	0	4	4	2	**CO-REQUISITE**	CC
6.	MMT 152	Mathematics Lab II	0	0	4	4	2	**CO-REQUISITE**	CC
7.	MDA156	Econometrics Lab	0	0	2	2	1		CC
TOTAL CREDITS							**20**		

Programme Structure Template

B. Sc. (Hons./ Hons. With Research) Mathematics **Batch: 2024-28**

TERM: 2702 (Semester-VIII)

S. No.	Course Code	Course Name	Teaching Load				Credits	Pre-Requisite/ Co-Requisite	Type of Course: 1. CC; 2. DSE; 3. Minor; 4. SEC; 5. AEC; 6. VAC; 7.Project
	THEORY		**L**	**T**	**P**	**TOTAL (hrs)**			
1.	MDA110	Time Series, Forecasting and Index Number	3	0	0	3	3		DSE
2.	MMT203	Linear Programming	4	0	0	4	4	Pre-requisite CMS131,202,232	Minor
3.	MMT107	Topology	4	0	0	4	4		Minor
4.	CMS401	Numerical Solution of Differential Equations	3	0	0	3	3	Pre-requisite CMS232, 331,332	DSE
	Practicals								
5.	MDA155	Time Series, Forecasting and Index Number Lab	0	0	2	2	1		DSE
6.	CMS451	Numerical Solution of Differential Equations Lab	0	0	2	2	1	Co-requisite CMS401	DSE
7.	MTR4854	**Project**	0	0	8	8	4		Project
TOTAL CREDITS							**20**		

OR (There are two options for semester VII and VIII)

Programme Structure Template

B. Sc. (Hons./ Hons. With Research) Mathematics **Batch: 2024-28**

TERM: 2701 (Semester-VII)

S. No.	Course Code	Course Name	Teaching Load				Credits	Pre-Requisite/ Co-Requisite	Type of Course: 1. CC; 2. DSE; 3. Minor; 4. SEC; 5. AEC; 6. VAC; 7.Project
	THEORY		**L**	**T**	**P**	**TOTAL (hrs)**			
1.	MMT108	DIFFERENTIAL GEOMETRY & TENSOR ANALYSIS	4	0	0	4	4	Pre-requisite MSM312	Minor
2.	MTT4703	Introduction to MATLAB and its Applications	4	0	0	4	4	**CO-REQUISITE**	CC
3.	STT4704	Probability and Statistical Methods	4	0	0	4	4	**CO-REQUISITE**	CC
4.	MMT 209	Econometrics	3	0	0	3	3	**CO-REQUISITE**	CC
	Practicals								
5.	MMT 151	Mathematics Lab- I	0	0	4	4	2	**CO-REQUISITE**	CC
6.	MMT 152	Mathematics Lab II	0	0	4	4	2	**CO-REQUISITE**	CC
7.	MDA156	Econometrics Lab	0	0	2	2	1		CC
8.	MTR4755	Research Project-I	0	0	6	6	3		Project
TOTAL CREDITS							**23**		

Programme Structure Template

B. Sc. (Hons./ Hons. With Research) Mathematics **Batch: 2024-28**

TERM: 2702 (Semester-VIII)

S. No.	Course Code	Course Name	Teaching Load				Credits	Pre-Requisite/ Co-Requisite	Type of Course: 1. CC; 2. DSE; 3. Minor; 4. SEC; 5. AEC; 6. VAC; 7.Project
	THEORY		**L**	**T**	**P**	**TOTAL (hrs)**			
1.	MMT205	FUNCTIONAL ANALYSIS	3	0	0	3	4		CC
2.	MMT202	MEASURE THEORY	4	0	0	4	4	Pre-requisite CMS131,202,232	Minor
3.	MTR4856	Research Project-II	0	0	18	18	9		Project
TOTAL CREDITS							**17**		

***Credited Research Project/Dissertation:** Students of B.Sc. Mathematics have the option to choose a research project/dissertation of worth 12 credits (However student has to take 23 credits courses including 3 credits project in 7th semester and 17 credits courses including 9 credits project in 8th semester). This can be undertaken for those who secure 75% and above marks in the first six semesters and wish to undertake research at the undergraduate level can choose a research stream in the fourth year. They should do a research project or dissertation under the guidance of a mathematics faculty member of the Sharda University. The students who secure 160 credits, including 12 credits from a research project/dissertation, are awarded **B.Sc. (Hons. with Research) Mathematics.**

B. Sc. (Hons. / Hons. With Research) Mathematics Curriculum Credits Distribution

Sem	CC	DSE	Minor	SEC	AEC	VAC	Project	Mathematics	Computer Science	Statistics
1	8	2	3	3	2	2	0	4	2	7
2	8	0	3	3	2	4	0	4	4	3
3	10	2	3	3	2	0	0	10	0	3
4	14	0	3	0	2	0	1	13	0	0
5	20	0	0	0	0	0	0	20	0	0
6	0	3	12	0	2	0	3	15	0	0
Total:	**60**	**7**	**24**	**9**	**10**	**6**	**4**	**66**	**6**	**13**
%	**50**	**5.84**	**20**	**7.5**	**8.34**	**5**	**3.34**	**55**	**5**	**10.84**
7	20	0	4*	0	0	0	0	20	0	0
8	0	8	8	0	0	0	4	12	0	4
Total:	**80**	**15**	**32**	**9**	**10**	**6**	**8**	**98**	**6**	**17**
%	**50**	**9.375**	**20**	**5.625**	**6.25**	**3.75**	**5**	**61.25**	**3.75**	**10.625**
OR										
7	16	0	4	0	0	0	3	**20**	**0**	**0**
8	4	0	4				9	**8**	**0**	**0**
Total:	**80**	**15**	**32**	**9**	**10**	**6**	**16**	**94**	**6**	**17**
%	**50**	**9.375**	**20**	**5.625**	**6.25**	**3.75**	**10**	**58.75**	**3.75**	**10.625**

List of Electives for B.Sc. (Hons. /Hons. With Research) Mathematics Students

Course Code	Mathematics	Course Code	Statistics
	DSE-1&2_7th sem (L-T-P:4-0-0)		**3rd sem (3-0-0)+(0-0-2)**
CMS402	Fluid Dynamics	BDA216 BDA261	Statistical Inference Statistical Inference Lab
MMT107	Topology (https://nptel.ac.in/courses/111106159)	BDA217 BDA262	Data Preparation and Data Cleaning Data Preparation and Data Cleaning Lab
MMT202	Measure Theory (https://nptel.ac.in/courses/111101100)		**4th sem_Stat/CS (4-0-0)+(0-0-2)**
CMS404	Introduction to Methods of Applied Mathematics (https://nptel.ac.in/courses/111102133)	BDA214 BDA272	Sampling Theory Sampling Theory Lab
CMS405	Computational Commutative Algebra (https://nptel.ac.in/courses/111106138)	BDA202 BDA271	Data Base Management Systems Data Base Management Systems Lab
CMS406	Measure and Integration (https://nptel.ac.in/courses/111106161)		**5th sem (2-0-0)+(0-0-2)**
CMS407	Competitive Mathematics: NPTEL-Advanced Engineering Mathematics (https://nptel.ac.in/courses/111107119)	BDA320 BDA359	Advanced Statistical Analysis Advanced Statistical Analysis Lab
	DSE-3_8th sem	BDA321 BDA363	Experimental Design Experimental Design Lab
NPTEL	Foundations of Cryptography (https://nptel.ac.in/courses/106106221)		**7th sem-1**
MMT205	Functional Analysis (https://nptel.ac.in/courses/111106147)	MDA110 MDA155	Time Series, Forecasting and Index Number (3-0-0) Time Series, Forecasting and Index Number Lab (0-0-2)
CMS435	Algebraic Combinatorics (https://nptel.ac.in/courses/111106158)	MDA111	Non-Parametric Statistical Inference (4-0-0)
CMS436	Fourier Analysis and its applications (https://nptel.ac.in/courses/111101164)		**7th sem-2**
CMS437	Applied Linear Algebra in AI and ML (https://nptel.ac.in/courses/111105165)	MDA112 MDA156	Econometrics (3-0-0) Econometrics Lab (0-0-2)
		MDA113	Survival Analysis (4-0-0)
			8th (4-0-0)
		MDA115	Demography
		MDA116	Statistical Quality Control

Detailed Syllabus for

CERTIFICATE COURSE IN

APPLIED MATHEMATICS

COURSE ARTICULATION MATRIX

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
MSM101	1.0	2.0		2.0							1.0			
CMS102	2.3	2.6	2.0	2.1		1.0					1.0			1.0
CSE113	1.0	2.0	2.0	3.0								1.0		
VOM103		2.0	1.0	2.0		1.0		3.0				1.0		1.0
ARP101						3.0		1.0	1.0	2.5	1.0			
VAC103	1.2	2.0			2.2	2.3			1.5	2.7	1.0			
CMS151	1.0	2.0	2.0	2.0		1.0	1.0	3.0	1.0		1.0	1.0		2.0
CSP113	2.2	3.0	2.2	2.7	2.2	2.5	2.5	2.5	2.3	2.0	1.0	1.0		1.0
CMS131	3.0	2.0	2.0	2.6		1.0					2.0	1.0	2.0	
CMS132		1.0		2.0							2.0	1.0	1.0	
CSE242	2.0	2.3	2.0	2.0							1.0			1.0
VOM104		3.0	1.0	2.0		1.0	1.0	3.0	1.0		2.0			1.0
ARP102						3.0	2.0	1.0	2.0		1.0			
CMS171	1.0	2.0	2.0	2.0		1.0	1.0	3.0	1.0		1.0	1.0		2.0
CSP242	1.0	2.0	2.0	2.0		1.0	1.0	3.0	1.0					1.0
CMS201	2.5	2.5	2.0	2.0		2.0							3.0	
CMS202	3.0	3.0	2.0	2.0		1.0					2.0	2.0	2.0	2.0
BDA215	1.0	2.0	2.0	1.0	2.0						2.0	2.0	2.0	
VOM2305		2.0	1.0	2.0		1.0		3.0					1.0	1.0
ARP207	1.0	2.0	2.0	2.0		1.0	1.0	3.0	1.0			1.0	2.0	
CMS251	2.0	2.0	2.0	2.0		1.0	1.0	3.0	1.0	1.0	1.0	2.0	2.0	2.0
CMS231	1.0	3.0	2.0	3.0	3.0	1.0					1.0	1.0	3.0	
CMS232	2.0	3.0	2.5	2.6	2.0	1.0					2.0	2.0	2.0	
ARP306									1	2.5	1	2		
CMS271	3.0	3.0	2.0	3.0	1.0	1.0	1.0	3.0	1.0	1.0	2.0	1.0	2.0	
CMS301	2.0	3.0	2.0	3.0		1.0					2.5	2.0	2.0	
CMS302	3.0	3.0	3.0	3.0		1.0						1.0	1.0	3.0
CMS303		2.5	2.0	2.0		1.0					1.0	3.0	3.0	
RBL003		2.0	1.0	2.0		1.0		3.0					1.0	1.0
INC001		2.0	1.0	2.0		1.0		3.0				1.0		1.0
CMS351	3.0	3.0	3.0	3.0	2.0	2.0	1.0	3.0	2.0	1.0	2.0	2.0	2.0	2.0
CMS331	3.0	3.0	3.0	3.0	2.0	1.0					2.0	2.0	2.0	
CMS332	2.5	2.5	2.5	2.6		1.0						2.0	2.0	
CMS333	3.0	3.0	2.5	2.6		1.0					2.0	2.0	2.0	
BDA323	2.3	2.6	2.0	2.1		1.0					2.0		1.0	
RBL004		2.0	1.0	2.0		1.0		3.0				1.0	1.0	1.0
CCU108	1.0	2.0	2.0	3.0	2.0	2.0	3.0	3.0	3.0	2.0	1.0	2.0	2.0	3.0
CMS371	3.0	3.0	3.0	3.0	2.0	1.0	2.0	3.0	2.3	2.0	3.0	2.0	2.0	2.0
CMS372	3.0	3.0	3.0	3.0	2.0	1.0	2.0	3.0	2.3	2.0	3.0	2.0	2.0	2.0
BDA361	1.0	2.0	3.0	2.0	2.0	1.0	1.0	3.0	1.0		2.0		1.0	2.0

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CMS401	3.0	3.0	3.0	3.0	2.0	1.0				2.0	3.0	3.0	2.0	3.0
CMS403	2.5	2.5	2.0	2.0		2.0							3.0	
CMS451	3.0	3.0	3.0	3.0	3.0	1.0	3.0	3.0	1.0	1.0	3.0	3.0	3.0	3.0
CMS431	3.0	3.0	2.0	2.0	2.0	1.0				1.0	3.0	3.0		
CMS432	3.0	3.0	3.0	3.0	2.0	1.0					3.0	3.0	3.0	
CMS433	3.0	3.0	3.0	3.0	2.0	1.0					2.0	2.0	2.0	

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

COURSE STRUCTURE

School: SSBSR		**Batch: 2024-28**	
Programme: B.Sc. (Hons.)		**Academic Year: 2024-25**	
Branch: Mathematics		**Semester: I**	
1	Course Code	**MSM101**	
2	Course Title	**Foundation Course in Mathematics**	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
	Course Status	CC	
5	Course Objective	1. To familiarize the students with basic concepts of matrices, determinants and solving the system of linear equations. 2. To understand the basic concept of sets theory, co-ordinate geometry, complex number and vector algebra.	
6	Course Outcomes	CO1: Explain the concept of matrices and solve systems of linear equations and determinants. (K2,K3, K4) CO2: Explain the concept of complex numbers and calculate the nth roots of complex numbers and illustrate the solutions of simple Polynomial equations. (K2, K3, K4) CO3: Memorize the basic of Cartesian coordinate system and use algebraic techniques to explain intercepts and explore equations of lines on the number plane. (K1, K3, K4) CO4: Describe and differentiate the symmetries from graphs of conic sections. (K1, K2) CO5: Describe and use the concepts of set theory, relation and functions. (K1,K2,K3) CO6: Explain the basic concepts of vector algebra and use to find area of parallelogram and quadrilateral, Vector triple product.(K2,K3,K4)	
7	Course Description	This course is an introduction to the fundamental of Mathematics. The primary objective of the course is to develop the basic understanding of linear algebra, complex number, co-ordinate geometry, sets theory and vector algebra	
8	**Outline syllabus**		**CO Mapping**
	Unit 1	**Matrices**	
	A	Evaluation of determinants, Properties of determinants,	CO1
	B	Matrices: types of matrices, addition, subtraction and multiplication of matrices, symmetric and skew symmetric matrix. Inverse of matrix.	CO1
	C	Rank of a matrix, Consistency of system of equations, Characteristic equation, Cayley -Hamilton theorem.	CO1
	Unit 2	**Complex Numbers**	
	A	Representation of complex number in Argand plane, Modulus and argument of complex number	CO2
	B	Algebraic operations, De- Moivre's theorem	CO2
	C	Nth root of complex number, Euler's formula	CO2
	Unit 3	**Co-ordinate geometry**	
	A	Cartesian coordinate system, Distance between two points Equations of line in various forms	CO3

	B	Equation of circle in various forms, Equation of tangent and normal to the circle.	CO3, CO4
	C	Equation of ellipse, parabola and hyperbola	CO3, CO4
	Unit 4	**Set Theory**	
	A	Definition of set, types of sets, Union and intersection of sets, Venn diagram, De-Morgan's law.	CO5
	B	Relation and functions.	CO5
	C	Composite function and inverse function.	CO5
	Unit 5	**Vector Algebra**	
	A	Addition and subtraction of vectors and their geometric application.	CO6
	B	Scalar and vector product, their physical application, Projection of vector on another vector, area of triangle.	CO6
	C	Area of parallelogram and quadrilateral, Vector triple product.	CO6
	Mode of examination	Theory	
	Weightage Distribution	CA:25%; ESE:75%	
	Text book/s*	1. Kreyszig, E., "Advanced Engineering Mathematics", John Wiley & Sons Inc.	
	Other References	1. Jain, M.K., and Iyengar, S.R.K., "Advanced Engineering Mathematics", Narosa Publications.	

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
MSM101.1	1	2		2							1			
MSM101.2	1	2		2							1			
MSM101.3	1	2		2							1			
MSM101.4	1	2		2							1			
MSM101.5	1	2		2							1			
MSM101.6	1	2		2							1			
Average	**1.0**	**2.0**		**2.0**							**1.0**			

School: SSBSR		**Batch: 2024-28**	
Programme: B.Sc. (Hons.)		**Academic Year: 2024-25**	
Branch: Mathematics		**Semester: I**	
1	Course Code	**CMS102**	
2	Course Title	**Descriptive Statistics**	
3	Credits	3	
4	Contact Hours (L-T-P)	3-0-0	
	Course Status	DSE	
5	Course Objective	1. To introduce basic statistical concepts, logics and analytical tools, analyze and communicatequantitative data verbally, graphically, symbolically and numerically. 2. To make students familiar with the concept of Probability and Statistics and display data utilizingvarious tables, charts, and graphs.	
6	Course Outcomes	CO1: Describe the process and particular steps in designing studies, collecting and analyzing data, interpreting and presenting results; and develop skills in presenting quantitative data using appropriatediagrams, tabulations and summaries. (K2, K5). CO2: Describe the properties of discrete and continuous distribution functions. (K2). CO3: Calculate the measures of central tendency and dispersion of a data and describe the method used for analysis, including a discussion of advantages, disadvantages, and necessary assumptions. (K2, K3) CO4: Calculate and interpret the correlation between two variables and Calculate the simple linearregression equation for a set of data and know the basic assumptions behind regression analysis. (K2,K3). CO5: Understand the line of best fit as a tool for summarizing a linear relationship and predicting future observed values, develop the ability to use formal mathematical argument in the context of probability. (K2, K5) CO6: Develop the skills to interpret the results of statistical analysis. (K2, K5).	
7	Course Description	This is an introductory course in statistics. Students are introduced to the fundamental concepts involved in using sample data to make inferences about populations. Included are the study of measures of central tendency and dispersion, finite probability, statistical inferences from large and small samples, linear regression, and correlation.	
8	**Outline syllabus**		**CO Mapping**
	Unit 1	**Presentation of data**	
	A	Classification, tabulation, diagrammatic & graphical representation of groupeddata.	CO1
	B	Frequency distributions, cumulative frequency distributions	CO1
	C	Histogram, Ogives, frequency polygon, Tree and leaf diagram.	CO1
	Unit 2	**Descriptive statistics**	CO2
	A	Measures of central tendency – arithmetic mean, median, quartiles, mode, harmonicmean, geometric mean.	CO2
	B	Their properties, merits, and demerits	CO2
	C	Measures of dispersion, range, quartile deviation, mean deviation, standard deviation,and coefficient of variation.	
	Unit 3	**Moments**	CO3

	A	Moments, Skewness, Measures of skewness: Karl Pearson's coefficient ofskewness.	CO3
	B	Quartile coefficient of skewness, Measure of skewness based on moments.	CO3
	C	Kurtosis, measure of Kurtosis.	
	Unit 4	**Bi-variate data analysis**	CO4
	A	Bivariate data, principles of least squares, fitting of polynomial curves, and fitting ofcurves reducible to polynomial form.	CO4
	B	Correlation: Spearman's rank correlation, Partial and Multiple Correlation (only two independent variables case).	CO4
	C	Regression lines.	
	Unit 5	**Probability**	CO5
	A	Probability: Introduction, random experiment, outcomes, sample space, events, various definitions of probability, laws of total and compound probability.	CO5
	B	Boole's inequality. Conditional probability, independence of events.	CO5
	C	Bayes theorem and its applications in real life problmes.	CO6
	Mode of examination	Theory	
	Weightage Distribution	CA:25%; ESE:75%	
	Text book/s*	1. Daniel, Wayne W., "Biostatistics": Basic concept and Methodology forHealth Science.	
	Other References	1. Rohatgi, V.K. Introduction to Probability.	

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CMS102.1	3	3	2	2		1					1			1
CMS102.2	2	3	3	2		1					1			1
CMS102.3	2	2	2	3		1					1			1
CMS102.4	2	3	2	2		1					1			1
CMS102.5	3	3	2	2		1					1			1
CMS102.6	3	3	2	3		1					1			1
Average	**2.3**	**2.6**	**2.0**	**2.1**		**1.0**					**1.0**			**1.0**

School: SSBSR		**Batch: 2024-28**	
Programme: B.Sc. (Hons.)		**Academic Year: 2024-25**	
Branch:Mathematics		**Semester: I**	
1	Course Code	**CSE113**	
2	Course Title	**Programming for Problem Solving**	
3	Credits	3	
4	Contact Hours (L-T-P)	3-0-0	
	Course Status	OPE	
5	Course Objective	1. Learn basic programming constructs data types,decision structures, control structures in C 2. Learning logic aptitude programming in c language 3. Developing software in c programming	
6	Course Outcomes	Students will be able to: CO1: **Demonstrate** the algorithm, Pseudo-code and flowchart for the given problem. CO2**: Develop** better understanding of basic concepts ofC programming. CO3: **Create** and implement logic using array andfunction. CO4: **Construct** and implement the logic based on theconcept of strings and pointers. CO5: **Apply** user-defined data types and I/O operationsin file. CO6: **Design** and develop solutions to real worldproblems using C.	
7	Course Description	Programming for problem solving gives the Understandingof C programming and implement code from flowchart or algorithm	
8	**Outline syllabus**		**CO Mapping**
	Unit 1	**Logic Building**	
	A	Flowchart: Elements, Identifying and understanding input/ output, Branching and iteration in flowchart	CO1
	B	Algorithm design: Problem solving approach(top down/bottom up approach)	CO1
	C	Pseudo Code : Representation of different construct, writing pseudo-code from algorithm and flowchart	CO1
	Unit 2	**Introduction to C Programming**	
	A	Introduction to C programming language, Data types, Variables, Constants, Identifiers andkeywords, Storage classes	CO2, CO6
	B	Operators and expressions, Types of Statements: Assignment, Control, jumping.	CO2, CO6
	C	Control statements: Decisions, Loops, break, continue	CO2, CO6
	Unit 3	**Arrays and Functions**	
	A	Arrays: One dimensional and multi dimensionalarrays: Declaration, Initialization and array manipulation (sorting, searching).	CO3, CO6
	B	Functions: Definition, Declaration/Prototypingand Calling, Types of functions, Parameter passing: Call by value, Call by reference.	CO3, CO6

	C	Passing and Returning Arrays from Functions, Recursive Functions.	CO3, CO6
	Unit 4	**Pre-processors and Pointers**	
	A	Pre-processors: Types, Directives, Pre- processors Operators (#,##,\) , Macros: Types, Use, predefined Macros	CO4, CO6
	B	Pointer: Introduction, declaration of pointervariables, Operations on pointers: Pointer arithmetic, Arrays and pointers, Dynamic memory allocation	CO4, CO6
	C	String: Introduction, predefined string functions,Manipulation of text data, Command Line Arguments	CO4, CO6
	Unit 5	**User Defined Data Types and File Handling**	
	A	Structure and Unions: Introduction, Declaration,Difference, Application, Nested structure, self- referential structure, Array of structures, Passing structure in function.	CO5, CO6
	B	Files: Introduction, concept of record, I/OStreaming and Buffering, Types of Files: Indexed file, sequential file and random file	CO5,CO6
	C	Creating a data file, Opening and closing a datafile, Various I/O operations on data files: Storingdata or records in file, adding records, Retrieving, and updating Sequential file/random file.	CO5,CO6
	Mode of examination	Theory	
	Weightage Distribution	CA:25%; ESE:75%	
	Text book/s*	1. Kernighan, Brian, and Dennis Ritchie. *The C Programming Language.*	
	Other References	1. B.S. Gottfried - Programming With C - Schaum's Outline Series - Tata McGraw Hill 2nd Edition - 2004.	

School: SSBSR		**Batch: 2024-28**	
Programme: B.Sc. (Hons.)		**Academic Year: 2024-25**	
Branch: Mathematics		**Semester: I**	
1	Course Code	**VOM103**	
2	Course Title	**Essential Excel Skills for Business**	
3	Credits	3	
4	Contact Hours (L-T-P)	0-0-6	
	Course Status	SEC	
5	Course Objective	1. To be able to enter, edit, and format data with ease using the Excel user interface. 2. To do calculations on data, use formulae and functions. Utilize functions to automate selections and data searches.	
6	Course Outcomes	CO1: How to operate essential navigational controls in Excel and how to perform basic data entry with Excel spreadsheets and understand the different cell references. CO2: Explain several formatting tools like font formatting, borders, alignment, number formatting, Excel styles, themes and printing options. CO3: Build charts to represent data visually using Pie, column and line charts and modify chart elements. CO4: Examine multiple sheets and workbooks to combine data, manage datasets and perform calculations across multiple sources. CO5: Decide ways to extract information and manipulate data to fulfil specific business requirements using text and date functions. CO6: Create, manage and apply Named Ranges to enhance calculations.	
7	Course Description	In offices all throughout the world, spreadsheet software continues to be one of the most frequently used programs. A significant tool will be added to your employability profile after you learn to use this software with assurance. Every day, there are millions of job postings in India alone that mention having Excel abilities. Digital skills contribute to higher income and better employment chances.	
8	**Outline syllabus**		**CO Mapping**
	Unit 1	**Critical Core of Excel and Performing Calculations**	
	A	Introduction, Taking Charge of Excel, Navigating and Selecting, View Options, Data Entry, Data Types, Editing and Deleting, Fill Handle, Copy and Paste, Templates.	CO1
	B	Formulas, Formulas in Context, Functions I: SUM and AUTOSUM.	CO1
	C	Functions II: AVERAGE, MIN and MAX, Absolute Cell References, Calculations across sheets.	CO1
	Unit 2	**Formatting and Printing**	
	A	Formatting, Borders, Alignment Tools, Format Painter, Number Formats, Styles and Themes.	CO2
	B	Managing Rows and Columns, Find and Replace, Filtering, Sorting, Conditional Formatting.	CO2
	C	Print Preview, Orientation, Margins and Scale, Page Breaks, Print Titles, Headers and Footers	CO2
	Unit 3	**Charts**	
	A	Basic Chart Types: Pie, Column and Line Charts.	CO3
	B	Move and Resize Charts, Change Chart Style & Type.	CO3
	C	Modify Chart Elements.	CO3C
	Unit 4	**Working with Multiple Worksheets & Workbooks**	

	A	Multiple Worksheets, 3D Formulas, Linking Workbooks.	CO4
	B	Consolidating by Position, Consolidating by Category (Reference).	CO4
	C	Combining Text (CONCAT, &), Changing Text Case (UPPER, LOWER, PROPER).	CO4
	Unit 5	**Named Ranges**	
	A	Extracting Text (LEFT, MID, RIGHT), Finding Text (FIND),	CO5
	B	Date Calculations (NOW, TODAY, YEARFRAC).	CO5
	C	Introducing Named Ranges, Creating Named Ranges, Managing Named Ranges, Named Ranges in Formulas, Apply Names.	CO6
	Mode of examination	Practical Based	
	Weightage Distribution	CA:25%; ESE:75%	
	Text book/s*	1. Michael Alexander, Excel® Dashboards & Reports For Dummies, John Wiley & Sons, Inc, ISBN: 978-1-119-07676-6, 2016.	
	Other References	1. Michael Alexander and Dick Kusleika, Excel 2016 Formulas, John Wiley & Sons, Inc, ISBN: 978-1-119-06786-3, 2016.	

School: SSBSR		**Batch :** 2024-28	
		Academic Year: 2024-25	
		Semester: I	
1	Course Code	**ARP101**	
2	Course Title	Communicative English-1	
3	Credits	2	
4	Contact Hours (L-T-P)	1-0-2	
5	Course Objective	To minimize the linguistic barriers that emerges in varied socio-linguistic environments through the use of English. Help students to understand different accents and standardise their existing English. Guide the students to hone the basic communication skills - listening, speaking, reading and writing while also uplifting their perception of themselves, giving them self-confidence and building positive attitude.	
6	Course Outcomes	After completion of this course, students will be able to: CO1: Develop a better understanding of advanced grammar rules and write grammatically correct sentences CO2: Acquire wide vocabulary and punctuation rules and learn strategies for error-free communication. CO3: Interpret texts, pictures and improve both reading and writing skills which would help them in their academic as well as professional career CO4: Comprehend language and improve speaking skills in academic and social contexts CO5: Develop, share and maximize new ideas with the concept of brainstorming and the documentation of key critical thoughts articulated towards preparing for a career based on their potentials and availability of opportunities. CO6:Function effectively in multi-disciplinary teams through the knowledge of team work, Inter-personal relationships, conflict management and leadership quality	
7	Course Description	The course is designed to equip students, who are at a very basic level of language comprehension, to communicate and work with ease in varied workplace environment. The course begins with basic grammar structure and pronunciation patterns, leading up to apprehension of oneself through written and verbal expression as a first step towards greater employability.	
8	Outline syllabus – ARP 101		
	Unit A	**Sentence Structure**	
	Topic 1	Subject Verb Agreement	CO1, CO2
	Topic 2	Parts of speech	
	Topic 3	Writing well-formed sentences	
	Unit B	**Vocabulary Building & Punctuation**	
	Topic 1	Homonyms/ homophones, Synonyms/Antonyms	CO1, CO2
	Topic 2	Punctuation/ Spellings (Prefixes-suffixes/Unjumbled Words)	CO1, CO2
	Topic 3	Conjunctions/Compound Sentences	CO1, CO2
	Unit C	**Writing Skills**	
	Topic 1	Picture Description – Student Group Activity	CO3
	Topic 2	Positive Thinking - Dead Poets Society-Full-length feature film - Paragraph Writing inculcating the positive attitude of a learner through the movie | SWOT Analysis – Know yourself	CO3, CO2, CO3
	Topic 3	Story Completion Exercise –Building positive attitude - The Man from	CO2,

		Earth (Watching a Full length Feature Film)	CO3
	Topic 4	Digital Literacy | Effective Use of Social Media	CO3
	Unit D	**Speaking Skill**	
	Topic 1	Self-introduction/Greeting/Meeting people – Self branding	CO4
	Topic 2	Describing people and situations - To Sir With Love (Watching a Full length Feature Film)	CO4
	Topic 3	Dialogues/conversations (Situation based Role Plays)	CO4
	Unit E	**Professional Skills | Career Skills**	
	Topic 1	Exploring Career Opportunities	CO4, CO5
	Topic 2	Brainstorming Techniques & Models	CO4, CO5
	Topic 3	Social and Cultural Etiquettes	CO4, CO5
	Topic 4	Internal Communication	CO4, CO5
	Unit F	**Leadership and Management Skills**	
	Topic 1	Managerial Skills	CO6
	Topic 2	Entrepreneurial Skills	CO6
	Evaluations	*Class Assignments/Free Speech Exercises / JAM Group Presentations/Problem Solving Scenarios/GD/Simulations (60% CA and 40% ETE*	*N/A*
	Text book/s*	1. Blum, M. Rosen. *How to Build Better Vocabulary*. London: Bloomsbury Publication	
	Other References	1. Comfort, Jeremy (et.al). *Speaking Effectively*. Cambridge University Press	

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
ARP101.1						3		1	1	3	1			
ARP101.2						3		1	1	3	1			
ARP101.3						3		1	1	3	1			
ARP101.4						3		1	1	2	1			
ARP101.5						3		1	1	2	1			
ARP101.6						3		1	1	2	1			
Average						**3.0**		**1.0**	**1.0**	**2.5**	**1.0**			

School: SSBSR		**Batch: 2024-28**	
Programme: B.Sc. (Hons.)		**Academic Year: 2024-25**	
Branch:Mathematics		**Semester: I**	
1	Course Code	**VAC103**	
2	Course Title	**Environmental Management**	
3	Credits	3	
4	Contact Hours (L-T-P)	3-0-0	
	Course Status	VAC	
5	Course Objective	1. Enable students to learn the concepts, principles and importance of Environmental Management 2. Provide students an insight of various causes of natural resource depletion and its conservation 3. Provide detailed knowledge of causes, effects and control of different types of environmental pollution and its effect on climate change, global warming and ozone layer depletion. 4. Provide knowledge of different methods of water conservation 5. Provide and enrich the students about sustainable practices and environmental management	
6	Course Outcomes	CO1.Develop a better understanding of the principles and scope of Environmental Management CO2. Acquire to learn various pollution causes, effects and control and solid waste management. CO3. Interpret the effect of global warming and ozone layer depletion CO4. Comprehend about various types of natural resources and its conservation CO5. Develop a better understanding about sustainable practices and environmental management CO6. Function effectively an overall understanding of various environmental components, its protection and management.	
7	Course Description	Environmental Management emphasises on various factors as 1. Importance and scope of Environmental Management 2. Natural resource conservation 3. Pollution causes, effects and control methods 4. Sustainable and Environmental environment	
8	**Outline syllabus**		**CO Mapping**
	Unit 1	**Natural resource management**	
	A	Introduction to Natural Resources	CO1
	B	Management of Land and Forest Resources	CO1
	C	Water and Energy resource Management	CO1
	Unit 2	**Environmental Pollution Management**	
	A	Air pollution Control and Water Pollution treatment Methods	CO2, CO6
	B	Soil and Noise Pollution Management	CO2, CO6
	C	Solid waste management	CO2, CO6
	Unit 3	**Climate Change Mitigation**	

	A	Concept of Global Warming and greenhouse effect	CO3, CO6
	B	Ozone layer Depletion and its consequences	CO3, CO6
	C	Climate change, its effect on ecosystem and its mitigation. Kyoto protocol and IPCC concerns on changing climate.	CO3, CO6
	Unit 4	**Natural resource conservation and management**	
	A	Hot spots, Endangered and endemic species of India	CO4, CO6
	B	Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts, biological invasions	CO4, CO6
	C	Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.	CO4, CO6
	Unit 5	**Sustainable practices and environmental management**	
	A	Sustainable development and sustainable consumption	CO5, CO6
	B	Environmental Issues and Management in India	CO5,CO6
	C	Environmental Management System (EMS)	CO5,CO6
	Mode of examination	Theory	
	Weightage Distribution	CA:25%; ESE:75%	
	Text book/s*	1. Textbook of Environmental Studies for Undergraduate Courses by Erach Bharucha, Pub: Orient Blackswan Pvt Ltd	
	Other References	1. Environmental Management by G. Tyler Miller, JR. and Scott E. Spoolman; Broks/Cole	

School: SSBSR		**Batch: 2024-28**	
Programme: B.Sc. (Hons.)		**Academic Year: 2024-25**	
Branch: Mathematics		**Semester: I**	
1	Course Code	**CMS151**	
2	Course Title	**Foundation Course in Mathematics Lab**	
3	Credits	1	
4	Contact Hours (L-T-P)	0-0-2	
	Course Status	CC	
5	Course Objective	1. To empower students with necessary analytic and technical skills to solve a variety of practical problems in science and engineering by plotting the graphs using different computer software such as Mathematica /MATLAB /Maple /Scilab/Maxima etc. 2. To make students appreciate the power and limitations of mathematics in solving practical real-life problems. 3. To equip students with the basic mathematical modelling skills.	
6	Course Outcomes	**CO1:** The main objective of the course is to equip the student to plot the different graph and solve the different types of equations by plotting the graph using different computer software such as Mathematica /MATLAB /Maple /Scilab/Maxima etc. (K1,K2,K3) **CO2.** After completion of this course student would be able to know the convergence of sequences through plotting, verify Bolzano-Weierstrass theorem through plotting the sequence, Cauchy's root test by plotting *n th* roots and Ratio test by plotting the ratio of *n th* and (*n* + 1)th term. (K2,K3) **CO3.** Student would be able to plot Complex numbers and their representations, Operations like addition, substraction, Multiplication, Division, Modulus and Graphical representation of polar form. (K2,K3,K4) **CO4**: Student would be able to perform following task of matrix as Addition, Multiplication, Inverse, Transpose, Determinant, Rank, Eigenvectors, Eigenvalues, Characteristic equation and verification of the Cayley-Hamilton theorem, Solving the systems of linear equations. (K2,K3,K4) **CO5**: Develop program scripts and functions using the Mathematica /MATLAB /Maple /Scilab/Maxima development environment. (K3,K4,K5) **CO6**: Write the program for evaluates linear system of equations, ordinary differential equations in Mathematica /MATLAB /Maple /Scilab/Maxima. (K4,K5,K6).	
7	Course Description	This course provides the fundamental basics of MATLAB. The primary objective of the course is to develop basic mathematical modelling and to solve various equations using MATLAB.	
8	**Outline syllabus**		**CO Mapping**
	Unit 1	**List of the practicals to be done using Mathematica /MATLAB /Maple /Scilab/Maxima etc.**	
	A	Plotting the graphs of the following functions: (i) ax (ii) [x] (greatest integer function)	CO1
	B	Plotting the graphs of the following functions: (iii) x 2n ; n ∈ N (iv) x 2n−1 ; n ∈ N	CO1
	C	Plotting the graphs of the following functions: (v)1 ; n ∈ N , X 2n−1	CO1

		(vi)1 ;n ∈ N X 2n	
	Unit 2	**Effect of Changes on Graphs**	
	A	Observe and discuss the effect of changes in the real constants a and b on the graphs. (vii) √ax + b, |ax + b|, c ± |ax + b| (viii) |X|, sin (1 , x sin 1 , e^X, e^−X for x ≠ 0.)	CO1, CO2
	B, C	(ix) e^ax+b, log(ax + b) , sin(ax + b), cos(ax + b) , |sin(ax+b)|,|cos(ax + b)|. ax+b	
	Unit 3	**Solution of Equation**	
	A, B, C	By plotting the graph find the solution of the equation x = ex, x2 + 1 = ex, 1 − x2 = ex, x = log10(x) , cos(x), etc	CO1, CO2
	Unit 4	**Plotting of Polynomial**	
	A, B, C	Plotting the graphs of polynomial of degree 2,3, 4 and 5, and their first and second derivatives.	CO2, CO3, CO4
	Unit 5	**Tracing**	
	A, B, C	1. Sketching parametric curves, e.g., Trochoid, Cycloid, Epicycloid and Hypocycloid etc. 2. Tracing of conic in Cartesian coordinates. 3. Graph of circular and hyperbolic functions. Obtaining surface of revolution of curves.	CO4, CO5, CO6
	Mode of examination	Practical+Viva	
	Weightage Distribution	CA:25%; CE:25%; ESE:50%	
	Text book/s*	1. MAT LAB Differential and Integral Calculus, Apress Grayson Street Suite 204 Berkely, CA United States	
	Other References	1.SOLVING APPLIED MATHEMATICAL PROBLEMS WITH MATLAB, CRC Press.	

School: SSBSR		**Batch: 2024-28**	
Programme: B.Sc. (Hons.)		**Academic Year: 2024-25**	
Branch:Mathematics		**Semester: I**	
1	Course Code	**CSP113**	
2	Course Title	**Programming for Problem Solving Lab**	
3	Credits	1	
4	Contact Hours (L-T-P)	0-0-2	
	Course Status	OPE	
5	Course Objective	1.Learn basic programming constructs data types,decision structures, control structures in C 2.Learning logic aptitude programming in c language 3.Developing software in c programming	
6	Course Outcomes	Students will be able to: CO1: **Implement** core concept of c Programming CO2: **Develop** programs using Array and String CO3: **Create** Functions for any problem CO4: **Use** Union and Structure to write any programCO5: **Implement** concept of Pointers CO6**: Design** a real world problem with the help of c programming	
7	Course Description	Programming for problem solving gives the Understanding of C programming and implement code from flowchart or algorithm.	
8	**Outline syllabus**		**CO Mapping**
	Unit 1	**Logic Building**	
	A	Draw flowchart for finding leap year	CO1
	B	Write a c Program to Add Two Integers	CO1
	C	Write a program to create a calculator	CO1
	Unit 2	**Introduction to C Programming**	
	A	Write a c program to convert length meter to cm	CO2, CO6
	B	Write a c program to convert temp	CO2, CO6
	C	Write a c program to swap two numbers	CO2, CO6
	Unit 3	**Arrays and Functions**	
	A, B, C	Write a c program to calculate the average using arrays Write a c program to find the largest element of the array	CO3, CO6
	Unit 4	**Pre-processors and Pointers**	
	A, B, C	Write a c program to swap two values using pointers Write a c program to find largest number from array using pointers	CO4, CO6
	Unit 5	**User Defined Data Types and File Handling**	

	A, B, C	Write a c program to store information of a student using structure Write a c program to store information of a student using union	CO5, CO6
	Mode of examination	Practical	
	Weightage Distribution	CA:25%; CE:25%; ESE:50%	
	Text book/s*	1. Kernighan, Brian, and Dennis Ritchie. *The C Programming Language*	
	Other References	1. B.S. Gottfried - Programming With C - Schaum's Outline Series - Tata McGraw Hill 2nd Edition - 2004.	

School: SSBSR		**Batch: 2024-28**	
Programme: B.Sc. (Hons.)		**Academic Year: 2024-25**	
Branch:Mathematics		**Semester: II**	
1	Course Code	**CMS131**	
2	Course Title	**Matrix Analysis and Linear Algebra**	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
	Course Status	CC	
5	Course Objective	1. To familiarize the students with basic concepts of matrices and its application in different prospects. 2. To understand the basic concept of linear algebra and inner product space.	
6	Course Outcomes	CO1: Describe the concept of algebra of matrices and elementary row operations and calculate the rank of matrix and analyse consistency of a linear system. (K1,K2,K3) CO2: Explain the concept of Eigenvalues and Eigenvectors; evaluate the diagonalization of matrices and quadratic & bilinear form. (K1,K2,K3) CO3: Discuss the basic of Vector spaces. (K2,K3,K4) CO4: Describe and use the linear transformation and evaluate nullity and kernel. (K2,K3,K4) CO5: Explain about the range and kernel and the basic introduction of Inner product spaces and orthogonal and orthonormal vectors. (K4,K5) CO6: Describe the application of rank, Eigenvalues, Eigenvectors, Gram-Schmidt orthogonalization. (K4,K5,K6)	
7	Course Description	This course introduces basics algebra of matrices, and its applications, vector space, Linear transformation and its properties, matrix representation of a linear transformation.	
8	**Outline syllabus**		**CO Mapping**
	Unit 1	**Matrix Analysis -I**	
	A	Course introduction and properties of Matrices, Elementary row operations, Echelon form of a matrix.	CO 1
	B	Rank of a Matrix, Normal form of a Matrix, Gauss-Jordan Method: Inverse of a Matrix by elementary operations.	CO 1
	C	Application of Rank: System of linear homogeneous and non-homogeneous equations, Theorems on consistency of a system of linear equations.	CO 1, CO 2
	Unit 2	**Matrix Analysis -II**	
	A	Eigenvalues, Eigenvectors and characteristic equation of a matrix.	CO2, CO 6
	B	Cayley Hamilton theorem and its application, Diagonalization.	CO 2
	C	Quadratic forms, Matrix of a quadratic forms, Bilinear forms, Matrix of a bilinear forms.	CO 2
	Unit 3	**Vector space and Linear Transformations -I**	
	A	Vector Space, Vector Subspaces and Linear Span, Linear Independence and Linear Dependence, Basic Results on Linear Independence.	CO 3, CO 4
	B	Basis of a Finite Dimensional Vector Space, Linear Transformations, Results on Linear Transformation.	CO 3, CO 4
	C	Range and Kernel of a Linear Transformation, Rank and	CO 3, CO 4

		Nullity, Rank-Nullity Theorem.	
	Unit 4	**Linear Transformations-II**	
	A	Linear operators, Invertible Linear Transformations.	CO 4, CO 5
	B	Matrix of a Linear Transformation, Matrix of the sum and product of linear transformations.	CO 5
	C	Linear transformation of a Quadratic Form and its theorems.	CO 4, CO 5
	Unit 5	**Orthogonality**	
	A	Inner Product Space (definition and examples), Cauchy-Schwartz inequality.	CO 5, CO 6
	B	Orthogonal and orthonormal vectors, Orthogonal and orthonormal bases	CO 5
	C	Gram-Schmidt Process, Orthogonal and positive definite matrices.	CO 6
	Mode of examination	Theory	
	Weightage Distribution	CA:25%; ESE:75%	
	Text book/s*	1.) Hoffman K & Kunze R, Linear Algebra, 2nd edition, Prentice Hall of India, 1975.	
	Other References	1.) Lipshutz S, Lipson M, Linear Algebra, 3rd edition, Schaum's Outline series, 2001.	

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CMS131.1	3	2	2	2		1					2	1		
CMS131.2	3	2	2	2		1					2	1		
CMS131.3	3	2	3	3		1					2	1		
CMS131.4	3	2	2	3		1					2	1		
CMS131.5	3	2	2	3		1					2	1		
CMS131.6	3	2	2	3		1					2	1		
Average	**3.0**	**2.0**	**2.0**	**2.6**		**1.0**					**2.0**	**1.0**		

School: SSBSR		**Batch: 2024-28**	
Programme: B.Sc. (Hons.)		**Academic Year: 2024-25**	
Branch: Mathematics		**Semester: II**	
1	Course Code	**CMS132**	
2	Course Title	**Mathematical Expectations & Probability Distributions**	
3	Credits	3	
4	Contact Hours (L-T-P)	3-0-0	
	Course Status	OPE	
5	Course Objective	Uncertainty is ubiquitous and probability theory provides a rational description of uncertainty. There is a growing realization that randomness is an essential component in modelling and analysis of a variety of systems. Probability has become an important conceptual framework of computer science, engineering, and physical and biological sciences. Several problems in computer engineering and other disciplines arise, which require probabilistic modelling. The complete specification of the model enquires statistical tools for the analysis of data and inference	
6	Course Outcomes	CO1: Describe the basic concepts of probability and randomness with their applications. (K2, K5). CO2: Describe the properties of discrete and continuous random variables. (K2). CO3: Calculate the measures of central tendency and dispersion of data and describe the method used for analysis, including a discussion of advantages, disadvantages, and necessary assumptions. (K2, K3) CO4: Calculate and interpret the probability distributions and their applications in real life; and limit theorems. (K2,K3). CO5: Monte Carlo simulation of simple probability models, entropy, and mutual information. (K2, K5) CO6: Develop the skills to interpret the results of statistical analysis. (K2, K5).	
7	Course Description	This is an introductory course in probability. Axioms of probability, conditional probability and independence, Bayes theorem, and probability distributions.	
8	**Outline syllabus**		**CO Mapping**
	Unit 1	**Mathematical Expectation**	
	A	Axioms of probability, conditional probability and independence, Bayes theorem,	CO1
	B	Random variables: discrete and continuous random variables, probability mass function (p.m.f), probability density function (p.d.f) and cumulative distribution function (c.d.f), Illustrations and properties of random variables.	CO1
	C	Mathematical Expectation: Expectation of single and bivariate random variables, properties of expectation, conditional expectation, and its properties. Moments and cumulants. Moment generating function, probability generating function.	CO1
	Unit 2	**Discrete Random Variable**	CO2
	A	Random variables, distribution function, discrete random variable, expectation, variance	CO2
	B	Discrete distributions: Bernoulli and Binomial random variable, Poisson random variable, demerits	CO2
	C	Negative binomial random variable, Geometric random variable, and their properties, merits, and demerits	
	Unit 3		CO3
	A	Continuous random variable: the expectation of random variable, variance	CO3

	B	Continuous distributions: Uniform, Normal, Exponential, Gamma, and Cauchy, computing probabilities by conditioning, moment generating function, their properties, merits, and demerits.	CO3
	C	Markov inequality and Chebyshev's inequality.	CO3
	Unit 4		CO4
	A	Jointly distributed random variables, Independent random variable, the sum of independent random variable	CO4, CO5
	B	Central Limit Theorem, conditional distribution with example.	CO4, CO5
	C	Joint probability distribution, covariance, correlation coefficient.	
	Unit 5		CO5
	A	Generation of random numbers and elements of Monte Carlo simulation.	CO5, CO6
	B	Elements of information theory: entropy as a measure of randomness.	CO5,CO6
	C	Exploratory data analysis, types of data, frequency tables, descriptive measures, variability measures	CO6
	Mode of examination	Theory	
	Weightage Distribution	CA:25%; ESE:75%	
	Text book/s*	1. Daniel, Wayne W., "Biostatistics": Basic Concept and Methodology forHealth Science.	
	Other References	1. Rohatgi, V.K. Introduction to Probability.	

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CMS132.1		1		2							2			1
CMS132.2		1		2							2			1
CMS132.3		1		2							2			1
CMS132.4		1		2							2			1
CMS132.5		1		2							2			1
CMS132.6		1		2							2			1
Average		**1.0**		**2.0**							**2.0**			**1.0**

School: SSBSR		**Batch: 2024-28**	
Programme: B.Sc. (Hons.)		**Academic Year: 2024-25**	
Branch:Mathematics		**Semester: II**	
1	Course Code	**CSE242**	
2	Course Title	**Data Structures**	
3	Credits	3	
4	Contact Hours (L-T-P)	3-0-0	
	Course Status	CC	
5	Course Objective	1. Learn the basic concepts of Data Structures. 2. Design and Implementation of Various Basic and Advanced Data Structures. 3. Learn the concepts of various searching, Sorting and Hashing Techniques. 4. Choose the appropriate data structures and algorithm design method for a specified application.	
6	Course Outcomes	CO1: **Select** appropriate data structures as applied to specified problem definition. CO2: **Choose** the suitable data structures like arrays, linked list, stacks and queues to solve real world problems efficiently. CO3 **Represent** and manipulate data using nonlinear data structures like trees and graphs to design algorithms for various applications. CO4: **Compare** various techniques for searching and sorting. CO5: **Design** and implement an appropriate hashing function for an application CO6: **Formulate** new solutions for programing problems or improve existing code using learned algorithms and data structures	
7	Course Description	This course starts with an introduction to data structures with its classification, efficiency of different algorithms, array and pointerbased implementations and Recursive applications. As the course progresses the study of Linear and Non-Linear data structures are studied in details. The course talks primarily about Linked list, stacks, queue, Tree structure, Graphs etc. This Course also deals with the concept of searching, sorting and hashing methods	
8			**CO Mapping**
	Unit 1	**Introduction**	
	A	Data Structure Definition, Operations and Applications, Abstract Data Types, Algorithm Definition, Introduction to Complexity, Big OH notation, Time and Space tradeoffs	CO1
	B	Dynamic Memory Allocation(Malloc, calloc, realloc, free), Recursion Definition, Examples- Tower of Hanoi problem,Tail Recursion	CO1
	C	Arrays: Implementation of One Dimensional Arrays, Multidimensional Arrays, Applications of Arrays, Address Calculation, Matrix Operations, Sparse matrices	CO1
	Unit 2	**Linked List**	
	A	Concept of Linked List, Garbage Collection, Overflow and Underflow, Array Implementation and Dynamic Implementation of Singly Linked Lists	CO2
	B	Array Implementation and Dynamic Implementation of Doubly Linked List, Circularly Linked List	CO2
	C	Operations on a Linked List- Insertion, Deletion, Traversal, Polynomial Representation and Addition	CO2

	Unit 3	**Stack and Queue**	
	A	Stacks: Definitions, Primitive operations, Application of stacks Conversion of Infix Expression to Postfix form, Evaluation of Postfix Expressions	CO3
	B	Queues: Definition, Primitive Operations, Implementation of Circular Queues, Priority Queues	CO3
	C	Deques, Application of Queues. Implementation - Linked Stacks, Linked Queues.	CO3
	Unit 4	**Tree and Graphs**	
	A	Trees: Terminologies, Binary tree, Representation, Applications, Binary search Tree Operations on Binary Search Trees (Traversing, Insertion, deletion etc.), Binary Search Algorithm, AVL Tree	CO4, CO6
	B	Graph: Terminology, Representation, Traversals- Depth First Search, Breadth First Search.	CO4, CO6
	C	Graph Applications Minimum Spanning Trees, Kruskal's Algorithms	CO4, CO6
	Unit 5	**Searching, Sorting and Hashing**	
	A	Implementation and Analysis - Linear search, Binary Search	CO5, CO6
	B	Implementation and Analysis- Bubble Sort, Insertion Sort, Selection Sort, Tree sort	CO5,CO6
	C	Hashing: Concepts and Applications, Hash Functions, Collisions, Methods of Resolving Collisions	CO5,CO6
	Mode of examination	Theory	
	Weightage Distribution	CA:25%; ESE:75%	
	Text book/s*	1. Lipschutz, Data Structures, Schaum's Outline series, TMH	
	Other References	1. Aaron M. Tenenbaum, Yedidyah Langsam and Moshe J. Augenstein "Data Structures Using C and C++", PHI	
		2.	

School: SSBSR		**Batch: 2024-28**	
Programme: B.Sc. (Hons.)		**Academic Year: 2024-25**	
Branch: Mathematics		**Semester: II**	
1	Course Code	**VOM104**	
2	Course Title	**Advanced Excel Skills for Business**	
3	Credits	3	
4	Contact Hours (L-T-P)	0-0-6	
	Course Status	SEC	
5	Course Objective	1. To work through challenges which are all too common ones that we encounter every day. 2. To learn to confidently operate this Excel means adding a highly valuable asset to employability portfolio.	
6	Course Outcomes	CO1: How to use functions like COUNTIFS to extract information from data, as well as generate graphical and table representations of it. CO2: Illustrate pivot tables and gain skills to create interactive dashboards with pivot charts and slicers. CO3: Apply data validation through conditional logic and conditional format. CO4: Analyze functions like CHOOSE, VLOOKUP, INDEX, MATCH and other dynamic lookups to find and display data from several sources. CO5: Evaluate errors, trace precedents and dependents, resolve circular references. CO6: Create protected worksheets and workbooks.	
7	Course Description	In offices all throughout the world, spreadsheet software continues to be one of the most frequently used programs. A significant tool will be added to your employability profile after you learn to use this software with assurance. Every day, there are millions of job postings in India alone that mention having Excel abilities. Digital skills contribute to higher income and better employment chances.	
8	**Outline syllabus**		**CO Mapping**
	Unit 1	**Summarizing Data and Tables**	
	A	COUNT functions, Counting with Criteria (COUNTIFS), Adding with Criteria (SUMIFS), Sparklines, Advanced Charting, Trendlines.	CO1
	B	Creating and Formatting Tables, Working with Tables, Sorting and Filtering in Tables	CO1
	C	Automation with Tables, Converting to Range and Subtotaling	CO1
	Unit 2	**Pivot Tables, Charts and Slicers**	
	A	Creating and Modifying a Pivot Table	CO2
	B	Value Field Settings, Sorting and Filtering a Pivot Table	CO2
	C	Reporting Filter Pages, Pivoting Charts, Pivoting Slicers	CO2
	Unit 3	**Data Validation and Conditional Logic**	
	A	Data Validation, Creating Drop-down Lists, Using Formulas in Data Validation	CO3
	B	Working with Data Validation, Advanced Conditional Formatting	CO3
	C	Logical Functions I: IF, Logical Functions II: AND, OR, Combining Logical Functions I: IF, AND, OR, Combining Logical Functions II: Nested Ifs, Handling Errors: IFERROR, IFNA	CO3
	Unit 4	**Automating Lookups**	
	A	Introduction to Lookups: CHOOSE	CO4

	B	Approximate Matches: Range VLOOKUP, Exact Matches: Exact Match VLOOKUP	CO4
	C	Finding a Position: MATCH, Dynamic Lookups: INDEX, MATCH	CO4
	Unit 5	**Formula Auditing and Protection**	
	A	Error Checking, Formula Calculation Options, Trace Precedents and Dependents	CO5
	B	Evaluate Formula, Watch Window	CO5
	C	Protecting Workbooks and Worksheets	CO6
	Mode of examination	Practical Based	
	Weightage Distribution	CA:25%; ESE:75%	
	Text book/s*	1. Michael Alexander, Excel® Dashboards & Reports For Dummies, John Wiley & Sons, Inc, ISBN: 978-1-119-07676-6, 2016.	
	Other References	1. Michael Alexander and Dick Kusleika, Excel 2016 Formulas, John Wiley & Sons, Inc, ISBN: 978-1-119-06786-3, 2016.	

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PSO 1**	**PSO 2**	**PSO 3**
VOM104.1		3	1	2		1	1	3	1		2		1	
VOM104.2		3	1	2		1	1	3	1		2		1	
VOM104.3		3	1	2		1	1	3	1		2		1	
VOM104.4		3	1	2		1	1	3	1		2		1	
VOM104.5		3	1	2		1	1	3	1		2		1	
VOM104.6		3	1	2		1	1	3	1		2		1	
Average		**3.0**	**1.0**	**2.0**		**1.0**	**1.0**	**3.0**	**1.0**		**2.0**		**1.0**	

Schools: SSBSR **B.Sc. Programme: B.Sc. (Hons.)** **Branch: Mathematics**		**Batch: 2024-28** **Academic Year: 2024-25** **Semester: II**	
1	Course Code	**ARP102**	
2	Course Title	**Communicative English -2**	
3	Credits	**2**	
4	Contact Hours (L-T-P)	**1-0-2**	
5	Course Type	**AEC**	
6	Course Objective	To Develop LSRW skills through audio-visual language acquirement, creative writing, advanced speech et al and MTI Reduction with the aid of certain tools like texts, movies, long and short essays.	
7	Course Outcomes	After completion of this course, students will be able to: CO1: Acquire Vision, Goals and Strategies through Audio-visual Language Texts CO2: Synthesize complex concepts and present them in creative writing CO3: Develop MTI Reduction/Neutral Accent through Classroom Sessions & Practice CO4: Determine their role in achieving team success through defining strategies for effective communication with different people CO5: Realize their potentials as human beings and conduct themselves properly in the ways of world. CO6 :Acquire satisfactory competency in use of Quantitative aptitude and Logical Reasoning	
8	Course Description	The course takes the learnings from the previous semester to an advanced level of language learning and self-comprehension through the introduction of audio-visual aids as language enablers. It also leads learners to an advanced level of writing, reading, listening and speaking abilities, while also reducing the usage of L1 to minimal in order to increase the employability chances.	
9	Outline syllabus – ARP 102		
	Unit A	**Acquiring Vision, Goals and Strategies through Audio-visual Language Texts**	
	Topic 1	Pursuit of Happiness / Goal Setting & Value Proposition in life	CO1
	Topic 2	12 Angry Men / Ethics & Principles	CO1
	Topic 3	The King's Speech / Mission statement in life | strategies & Action Plans in Life	CO1
	Unit B	**Creative Writing**	
	Topic 1	Story Reconstruction - Positive Thinking	CO2
	Topic 2	Theme based Story Writing - Positive attitude	
	Topic 3	Learning Diary Learning Log – Self-introspection	
	Unit C	**Writing Skills 1**	
	Topic 1	Precis	CO2
	Topic 2	Paraphrasing	
	Topic 3	Essays (Simple essays)	
	Unit D	**MTI Reduction/Neutral Accent through Classroom Sessions & Practice**	
	Topic 1	Vowel, Consonant, sound correction, speech sounds,	CO3

		Monothongs, Dipthongs and Tripthongs	
	Topic 2	Vowel Sound drills , Consonant Sound drills, Affricates and Fricative Sounds	
	Topic 3	Speech Sounds | Speech Music| Tone | Volume| Diction |Syntax |Intonation | Syllable Stress |	
	Unit E	**Gauging MTI Reduction Effectiveness through Free Speech**	
	Topic 1	Jam sessions	CO3
	Topic 2	Extempore	
	Topic 3	Situation-based Role Play	
	Unit F	**Leadership and Management Skills**	
	Topic 1	Innovative Leadership and Design Thinking	CO4
	Topic 2	Ethics and Integrity	CO4
	Unit F	**Universal Human Values**	
	Topic 1	Love & Compassion, Non-Violence & Truth	CO5
	Topic 2	Righteousness, Peace	CO5
	Topic 3	Service, Renunciation (Sacrifice)	CO5
	Unit G	**Introduction to Quantitative aptitude & Logical Reasoning**	
	Topic 1	Analytical Reasoning & Puzzle Solving	CO6
	Topic 2	Number Systems and its Application in Solving Problems	CO6
10	Evaluations	1. *Class Assignments/Free Speech Exercises / JAM Group Presentations/Problem Solving Scenarios/GD/Simulations (60% CA and 40% ETE*	*N/A*
11	Texts & References | Library Links	1. Comfort, Jeremy(et.al). *Speaking Effectively*. Cambridge University Press. The Luncheon by W.Somerset Maugham - http://mistera.co.nf/files/sm_luncheon.pdf	

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
ARP102.1						3	2	1	2		1			
ARP102.2						3	2	1	2		1			
ARP102.3						3	2	1	2		1			
ARP102.4						3	2	1	2		1			
ARP102.5						3	2	1	2		1			
ARP102.6						3	2	1	2		1			
Average						**3.0**	**2.0**	**1.0**	**2.0**		**1.0**			

School: SSBSR		**Batch: 2024-28**	
Programme: B.Sc. (Hons.)		**Academic Year: 2024-25**	
Branch: Computational Mathematics & Statistics		**Semester: II**	
1	Course Code	**VAC110**	
2	Course Title	**Yoga for Holistic Health**	
3	Credits	3	
4	Contact Hours (L-T-P)	0-1-4	
	Course Status	VAC	
5	Course Objective	**0-1-4**	
		To make the students familiar with the different practices of yoga, cl techniques and learn the correct teaching skills.	
6	Course Outcomes	CO1: To make the students understand the concept of health and wellness through Yoga CO2 To define the concept and principles of Yoga. CO3: To interpret and understand the breathing practice. CO4: To describe the knowledge about Yoga, its foundations and applications to the aspirants. CO5: To make students aware of Yogic impact on the positive health and personality development. CO6: The students will learn primary level of Yoga practices, which will groom their personality.	
7	Course Description		
8	**Outline syllabus**		**CO mapping**
	Unit 1	**Importance of Health, Wellness through Yoga**	
	A	Meaning, Definition, Aim of Yoga; Concept of health according to WHO and Ayurveda	CO1, CO2, CO4, CO5, CO6
	B	Misconception about Yoga, Difference between asana and physical exercise	CO1, CO2, CO4, CO5, CO6
	C	Need, Importance of Yoga in health and wellness	CO1, CO2, CO4, CO5, CO6
	Unit 2	**Schools of Yoga, Modern and Ancient schools of Yoga existing in India, Yogic diet, Yogic attitudes, Sadhak tatva & Badhak tatva**	
	A	Schools/ Streams of Yoga – Ashtanga Yoga, Bhakti Yoga, Karma Yoga, Jnana Yoga	CO3, CO4, CO5, CO6
	B	Modern and ancient schools of Yoga existing in India – Natha Sampradaya, Kaivalyadhama, Bihar School of Yoga, Munger, Pragya Yoga (Shantikunj), Iyengar Yoga, Patanjali Yoga Peeth,	CO3, CO4, CO5, CO6

		Ashtanga Vinyasa Yoga	
	C	Yoga Ahaara (Yogic diet), Yogic Attitudes – Maitri Karuna, Mudita, Upeksha, Sadhak Tatva Badhak Tatva (facilitating/helping factors and obstacles in Yoga sadhana)	CO3, CO4, CO5, CO6
	Unit 3	**Beginner level practices – Sukshma Vyayama and Surya Namaskara**	
	A	Sukshma Vyayama and their benefits for health Part-1 (Bihar School of Yoga) Part-1	CO4, CO5, CO6
	B	Sukshma Vyayama & their benefits for health (Swami Dhirendra Brahmachari) Part-1	CO4, CO5, CO6
	C	Surya Namaskara (Sun Salutation) with mantra chanting (12 steps) & their benefits for health	CO4, CO5, CO6
	Unit 4	**Asana - all categories**	
	A	Standing & Sitting - Tadasana, Vrikshasana, Katichakrasana, Padmasana, Vajrasana, Ushtrasana, Paschimottanasana, Vakrasana	CO4, CO5, CO6
	B	Supine and Prone: Uttanapadasana, Pawanamuktasana, Shalabhasana, Bhujangasana	CO4, CO5, CO6
	C	Balancing and Inverted: Trivikramasana, Sarvangasana, Viparitakarani mudra	CO4, CO5, CO6
	Unit 5	**Pre-practices of Pranayama, Pranayama and Dhyana**	
	A	Kapalabhati, Mukha dhauti, Vibhagiya pranayama (Sectional breathing)	CO1, CO4, CO5, CO6
	B	Anuloma – Viloma, Bhastrika, Shitali	CO1, CO4, CO5, CO6
	C	Om Dhyana, Aanapaanasati Dhyana (breath meditation)	CO1, CO4, CO5, CO6
	Mode of examination	Theory and Practical	
	Weightage Distribution	CA:60%; ESE:40%	
	Text book/s*	Sri Ananda: The Complete book of Yoga, Orient Course Backs, Delhi,2003.	
	Other References	1. Sri Ananda: The Complete book of Yoga, Orient Course Backs, Delhi,2003. 2. Basavaraddi, I.V. & other: SHATKARMA: A Comprehensive description about Cleansing Process, MDNIY New Delhi, 2009	

		3. Joshi, K.S.: Yogic Pranayama, Oriental Paperback, New Delhi, 2009 4. Dr. Nagendra H R: Pranayama, The Art & Science, Swami Vivekananda Yoga Prakashan, Bangalore, 2005. 5. Swami Niranjanananda Saraswati: Asana Pranayama Mudra Bandha, Yoga Publication Trust, Munger Bihar. 6. Joshi, K.S.: Yogic Pranayama, Oriental Paperback, New Delhi, 2009 7. Swami Kuvalyananda: Pranayama, Kaivalyadhama, Lonavla, 2010 8. Swami Rama: Science of Breath, A Practical Guide, The Himalayan International Institute, Pennselvenia, 1998. 9. Swami Niranjanananda Saraswati: Prana, Pranayama & Pranavidya, Yoga Publications Trust, Munger, Bihar, 2005	

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
VAC110.1	1	3	3	3	2	1	2	3	2	3	2	1	3	3
VAC110.2	1	2	3	1	3	1	3	2	2	3	1	1	2	3
VAC110.3	1	1	3	3	3	3	2	3	2	3	2	1	1	3
VAC110.4	1	2	3	3	1	2	3	2	3	2	1	1	2	3
VAC110.5	2	2	3	3	1	3	3	2	3	1	2	2	2	3
VAC110.6	3	3	2	2	3	1	2	3	1	2	3	3	3	2
Average	**1.5**	**2.2**	**2.8**	**2.5**	**2.2**	**1.8**	**2.5**	**2.5**	**2.2**	**2.3**	**1.8**	**1.5**	**2.2**	**2.8**

School: SSBSR		**Batch: 2024-28**	
Programme: B.Sc. (Hons.)		**Academic Year: 2024-25**	
Branch: Mathematics		**Semester: II**	
1	Course Code	**CMS171**	
2	Course Title	**Matrix Analysis and Linear Algebra Lab**	
3	Credits	1	
4	Contact Hours (L-T-P)	0-0-2	
	Course Status	CC	
5	Course Objective	1.To familiarize the students with use of MATLAB in Matrix analysis. 2.To understand the use of MATLAB in Linear Algebra.	
6	Course Outcomes	The student will be able to write a code in Mathematica /MATLAB /Maple /Scilab/Maxima CO1: to transform a matrix into echelon form and to find the rank. (K1, K2, K3) CO2: to find the inverse, and eigenvalues & eigenvectors of a matrix and also solution of a system of equations. (K1, K2, K3) CO3: to verify Cayley-Hamilton theorem. (K2, K3) CO4: to understand Quadratic and Bilinear forms with the help of MATLAB. (K3, K4, K5) CO5: to apply the concept for vectors linear dependency and independency and also Linear Transformations. (K4, K5, K6) CO6: to discuss the Gram-Schmidt Process and the concept of eigenvalues and eigenvectors. (K4, K5, K6)	
7	Course Description	The course is an introduction to the MATLAB in Matrix analysis and Linear algebra. The primary objective of the course is to develop basic mathematical modelling and to solve various equations using MATLAB.	
8	**Outline syllabus**		**CO Mapping**
	Unit 1		
	A, B, C	Algebra of Matrices, Echelon form of a Matrix, Rank of a Matrix.	CO 1
	Unit 2		
	A, B, C	Gauss-Jordan Method for finding Inverse, System of Equations, Eigenvalues, Eigenvectors.	CO 2, CO 6
	Unit 3		
	A, B, C	Matrix of a Quadratic forms, Matrix of a Bilinear forms, Cayley Hamilton Theorem.	CO 3
	Unit 4		
	A, B, C	Linear dependence and linear independence of vectors, Linear Transformation, Inner Product Space	CO 4
	Unit 5		
	A, B, C	Orthogonal Vectors, Orthonormal Vectors, Gram-Schmidt Process.	CO 5, CO 6
	Mode of examination	Practical+ viva	
	Weightage Distribution	CA:25%; CE:25%; ESE:50%	

	Text book/s*	1.) D.R. Hill and D.E. Zitarelli, Linear Algebra Labs with MATLAB, Second edition, Prentice Hall, Upper Saddle River, NJ, 1996.	
	Other References	1.) B. Kolman, Introductory Linear Algebra with Applications, Sixth edition, Prentice Hall, Upper Saddle River, NJ, 1997.	

School: SSBSR		**Batch: 2024-28**	
Programme: B.Sc. (Hons.)		**Academic Year: 2024-25**	
Branch:Mathematics		**Semester: II**	
1	Course Code	**CSP242**	
2	Course Title	**Data Structures Lab**	
3	Credits	1	
4	Contact Hours (L-T-P)	0-0-2	
	Course Status	CC	
5	Course Objective	1. Learn the basic concepts of Data Structures. 2. Design and Implementation of Various Basic and Advanced Data Structures. 3. Learn the concepts of various searching, Sorting and Hashing Techniques. 4. Choose the appropriate data structures and algorithm design methodfor a specified application	
6	Course Outcomes	CO1: **Implement** operation like traversing, insertion, deletion, searching etc.on various data structures. CO2 **Apply** linear data structure(s) to solve various problems CO3:**D evelop** the solution of any problem using non linear data structure(s) CO4: **Create** a solution of any problem using searching and sorting techniques CO5: **Design** a hash function using any programming language CO6: **Choose** the most appropriate data structure(s) for a given problem.	
7	Course Description	This course starts with an introduction to data structures with its classification, efficiency of different algorithms, array and pointer based implementations and Recursive applications. As the course progresses the study of Linear and Non-Linear data structures are studied in details. The course talks primarily about Linked list, stacks,queue, Tree structure, Graphs etc. This Course also deals with the concept of searching, sorting and hashing methods	
8	**Outline syllabus**		**CO Mapping**
	Unit 1	**Introduction**	
	A	Program to implement Operation on Array such as Traversing, Insertion & Deletion operation	CO1
	B	Program based on Recursion such as Towers of Hanoi, Fibonacci series etc	CO1
	Unit 2	**Linked List**	
	A,B, C	Program to implement different operation on the following linked list: Singly, Doubly and circular linked list.	CO2
	Unit 3	**Stack & Queue**	
	A	Program to Implement Stack operation using Array and Linked list	CO3
	B	Program to convert infix expression to post fix expression Program on Evaluation of Post fix expression	CO3
	C	Program to implement queue operation using array and linked list Program to implement circular queue and deque.	CO3
	Unit 4	**Tree & Graph**	
	A	Program to implement binary tree and BST.	CO4, CO6

	B	Program to implement MST and shortest path algorithm.	CO4, CO6
	Unit 5	**Searching, Sorting & Hashing**	
	A, B	Program on Searching and Hashing Program on Sorting.	CO5
	Mode of examination	Practical	
	Weightage Distribution	CA:25%; CE:25%; ESE:50%	
	Text book/s*	1. Lipschutz, Data Structures, Schaum's Outline series, TMH	
	Other References	1. Jean Paul Trembley and Paul G. Sorenson, "An Introduction to Data Structures with Applications", McGraw Hill	

School: SSBSR		**Batch: 2024-28**	
Programme: B.Sc. (Hons./Hons. With Research) Mathematics		**Academic Year: 2025-26**	
Branch: Mathematics		**Semester: III**	
1	Course Code	**CMS201**	
2	Course Title	**Abstract Algebra**	
3	Credits	5	
4	Contact Hours (L-T-P)	5-0-0	
	Course Status	CC	
5	Course Objective	To familiarise students with basic concepts of group, subgroup, cyclic group and permutation groups. The basic idea of cosets, normal subgroups, normalizer, centre, stabilizer and orbit. Concepts of homomorphism, isomorphism, automorphism and inner automorphism. The different algebraic structures ring, integral domain, field, ideal and quotient ring, prime and maximal ideal. The principal ideal domain, polynomial ring, division algorithm, Euclidean rings.	
6	Course Outcomes	CO1: Describe the concept of group, subgroup, cyclic group and permutation groups. (K1, K2, K3) CO2: Explain the concept of cosets, normal subgroups, normalizer, centre, stabilizer and orbit. (K2, K3, K4) CO3: Recognize and decide homomorphism group, isomorphic groups, automorphism and inner automorphism. (K1, K3, K6) CO4: Define and discriminate Ring integral domain, field ideal and quotient ring, prime and maximal ideal. (K4, K5, K6) CO5: Discuss about Principal ideal domain and evaluate polynomial ring. (K1, K2, K5) CO6: Explain Euclidean rings and develop division algorithm. (K2, K4, K6)	
7	Course Description	This course will cover basic concepts of group, subgroup, cyclic group and permutation groups. The basic idea of cosets, normal subgroups, normalizer, centre, stabilizer and orbit. Concepts of homomorphism, isomorphism, automorphism and inner automorphism. The different algebraic structures ring, integral domain, field, ideal and quotient ring, prime and maximal ideal. The principal ideal domain, polynomial ring, division algorithm, Euclidean rings.	
8	**Outline syllabus**		**CO Mapping**
	Unit 1	**Group theory-1**	
	A	Binary operations, Groups, subgroups	CO1
	B	Order of a group, cyclic group	CO1
	C	Group of permutations, cycles and alternating group.	CO1
	Unit 2	**Group theory-2**	
	A	Cosets, Normal subgroup, Normalizer	CO2
	B	Centre, stabilizer and orbits of groups	CO2
	C	Statement of Lagrange's theorem.	CO2
	Unit 3	**Group theory-3**	
	A	Homomorphism of groups, kernel of homomorphism	CO3
	B	Definition of isomorphism, automorphism,	CO3

	C	Inner automorphism, Factor group.	CO3
	Unit 4	**Ring Theory -1**	
	A	Rings, Integral Domains and Fields	CO4
	B	Ideal and quotient Rings	CO4
	C	Prime and maximal ideals	CO4
	Unit 5	**Ring Theory -2**	
	A	Principal ideal domains	CO5
	B	Polynomial Rings, Division algorithm	CO5, CO6
	C	Euclidean Rings, The ring Z[i]	CO6
	Mode of examination	Theory	
	Weightage Distribution	CA:25%; MSE:25% ; ESE:50%	
	Text book/s*	J. B. Fraleigh, A first course in Abstract Algebra, Addison Weley.	
	Other References	1. J. A. Gallian, Contemporary Abstract Algebra, 10th edition, CRC. Press.	

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS 11	PSO 1	PSO 2	PSO 3
CMS201.1	3	3	2	2		2							3	
CMS201.2	2	3	2	2		2							3	
CMS201.3	2	2	2	2		2							3	
CMS201.4	2	3	2	2		2							3	
CMS201.5	3	2	2	2		2							3	
CMS201.6	3	2	2	2		2							3	
Average	**2.5**	**2.5**	**2.0**	**2.0**		**2.0**							**3.0**	

School: SSBSR		**Batch: 2024-28**
Programme: B.Sc. (Hons./Hons. With Research) Mathematics		**Academic Year: 2025-26**
Branch: Mathematics		**Semester: III**
1	Course Code	**CMS202**
2	Course Title	**Calculus**
3	Credits	3
4	Contact Hours(L-T-P)	3-0-0
	Course Status	CC
5	Course Objective	1. To familiarize the students with basic concepts of successive differentiation along with the concepts of partial differentiation, basic integration &multiple integration. 2. To understand the basic concept of basic theory of calculus and its applications in real life.
6	Course Outcomes	Students will be able to: CO1: Define the basic of differentiation &Successive Differentiation and solve with Leibnitz's theorem. (K1, K3). CO2: Explain and solve the Taylor's theorem, Maclaurin's theorem of one variable& two variables, Maxima minima for one & two variables, Lagrange multipliers method and point of inflexion for various functions. (K1, K2, K3). CO3: Describe the Partial differentiation, Homogeneous functions and drive Euler's theorem with applications and apply the concept of Jacobian and its applications. (K1, K2, K3,). CO4: Determine the Beta and Gamma functions. (K1, K3, K6). CO5: Evaluate the double integrals, Change of order of integration, change of variables, and applications. (K4, K6). CO6: Evaluate the Triple integrals and its application. (K2, K5, K6).
7	Course Description	This course is to introduce the concepts of Differentiation, successive differentiation along with the concepts of partial differentiation, basic integration & multiple integration. A brief of formulation and evaluation of double integration and its applications.

8	**Outline syllabus**: **Calculus**		**CO Mapping**
	Unit 1	**DIFFERENTIATION**	
	A	Concepts of limit, continuity and differentiability, differentiation of standard functions, product and quotient rule for differentiation, chain rule.	CO1
	B	Successive differentiation and its applications, Leibnitz's theorem.	CO1
	C	Taylor's theorem, Maclauri's theorem, Maxima-minima, Points of inflexion	CO1
	Unit 2	**PARTIAL DIFFERENTIATION**	
	A	Partial differentiation, homogeneous functions, Euler's theorem.	CO2
	B	Jacobian of explicit and implicit functions and its applications, Taylor's expansion in two variables.	CO2
	C	Maxima-minima in two variables, Lagrange's multipliers method	CO2
	Unit 3	**Tracing of Plane Curves**	
	A	Asymptotes of the algebraic curves, parallel asymptotes, Asymptotes parallel to x-axis and y-axis, Curvature: Polar coordinates	CO3

	B	Equation of the tangent(s) at the origin and conjugate points.	CO3
	C	Curve tracing-Cartesian curves and polar curves	CO3
	Unit 4	**DOUBLE INTEGRATION**	
	A	Evaluation of double integrals	CO4
	B	Beta and Gamma functions ,Change of order of integration, change of variables	CO4
	C	Application of double integrals.	CO4
	Unit 5	**TRIPLE INTEGRATION**	
	A	Evaluation of triple integrals, Triple integrals in Rectangular, Cylindrical and Spherical coordinates.	CO5
	B	Volume and Surfaces of solids of revolution for Cartesian, parametric and polar curves.	CO5
	C	Applications of triple integrals	CO6
	Mode of examination	Theory	
	Weightage Distribution	CA:25%; MSE:25% ; ESE:50%	
	Text book/s*	1. N. Piskunov: Differential and Integral Calculus.	
	Other References	1. Thomas, B.G., and Finny R.L. ,"Calculus and Analytical Geometry", Pearson education Asia, Adison Wesley.	

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CMS202.1	3	3	2	2		1					2			
CMS202.2	3	3	2	2		1					2			
CMS202.3	3	3	2	2		1					2			
CMS202.4	3	3	2	2		1					2			
CMS202.5	3	3	2	2		1					2			
CMS202.6	3	3	2	2		1					2			
Average	**3.0**	**3.0**	**2.0**	**2.0**		**1.0**					**2.0**			

School: SSBSR		**Batch: 2024-28**	
Programme: B.Sc. (Hons./Hons. With Research) Mathematics		**Academic Year: 2025-26**	
Branch: Mathematics		**Semester: III**	
1	Course Code	**BDA215**	
2	Course Title	**Operations Research**	
3	Credits	3	
4	Contact Hours (L-T-P)	3-0-0	
0	Course Status	Minor	
5	Course Objective	3. To familiarize the students with basic concepts of optimization and classification of optimization problems. 4. To understand the basic concept of Formulation simplex methods variable with upper bounds.	
6	Course Outcomes	Students will be able to: CO1: Explain the fundamental knowledge of Linear Programming problem and Duality problems. (K1, K2, K3). CO2: Use classical optimization techniques and numerical methods of optimization. (K2, K3, K4). CO3: Describe the basics of different NLPP and KKT conditions. (k3, K4). CO4: Enumerate fundamentals of Integer programming technique and apply different techniques to solve various optimization problems arising from engineering areas. (K2, K3, K4). CO5: Students will understand the concept of LPP and NLPP and will be able to solve some real-life problems using optimization techniques. (K3, K4, K5) CO6: Explain the fundamental knowledge of Linear Programming and Dynamic Programming problems. (K4, K5, K6).	
7	Course Description	This course is an introduction to the basic understanding of with applications and scope of O.R. Formulation of linear programming problems and then different methods to solve them will be discussed. Duality in LPP will be introduced. An introduction to NLPP and some solving methods will be covered. At the end KKT Conditions, Unconstrained and constrained optimization techniques will be discussed.	
8	**Outline syllabus**		**CO Mapping**
	Unit 1	**Introduction to LPP, Graphical Method, and Simplex Method**	
	A	Introduction to Optimization, Assumptions & Mathematical Modeling of LPP, Graphical Solution of L.P.P., Graphical Solution of LPP-I, Graphical Solution of LPP- II.	CO1
	B	Solution of L.P.P. by Simplex method, Revised Simplex Method, Introduction of Big M method, Algorithm of BIG-M method.	CO1
	C	Problems on BIG-M Method, Two Phase Method: Introduction and Two-Phase Method: Problem Solution.	CO1
	Unit 2	**Duality Theory and Integer Programming**	
	A	Special Cases of LPP, Degeneracy in LPP, Sensitivity Analysis- I, Sensitivity Analysis- II, and Problems on Sensitivity Analysis.	CO2
	B	Introduction to Duality Theory- I, Introduction to Duality Theory- II, Dual Simplex Method and Examples on Dual Simplex Method.	CO2
	C	Integer Linear Programming, IPP: Branch & B-Bound Method and Mixed Integer Programming Problem.	CO2
	Unit 3	**Introduction to transportation problem and Some Solving Methods**	

	A	Introduction to transportation problem-I, Transportation problem-II, Vogel Approximation method, optimal solution Generation for Transportation problem and Degeneracy in TP and problems.	CO3
	B	Introduction to Nonlinear Programming, Graphical Solution of NLP, and Types of NLP.	CO3
	C	One-dimensional unconstrained optimization, Region Elimination Technique-1, Region Elimination Technique-2, and Region Elimination Technique-3.	CO3
	Unit 4	**NLP and Unconstrained optimization**	
	A	Multivariate Unconstrained Optimization-1, Multivariate Unconstrained Optimization-2.	CO4
	B	NLP with Equality Constrained-1, NLP with Equality Constrained-2, Constrained NLP-1, and Constrained NLP 2.	CO4
	C	Constrained Optimization, Constrained Optimization, and KKT (Karush-Kuhn-Tucker conditions)	CO4
	Unit 5	**Constrained optimization and Dynamic programming of LPP**	
	A	Constrained Optimization, Constrained Optimization, and Feasible Direction.	CO5
	B	Penalty and barrier method, Penalty method, and Penalty and barrier method.	CO5
	C	Dynamic programming, Multi-Objective decision-making, and Multi-Attribute decision-making.	CO6
	Mode of examination	Theory	
	Weightage Distribution	CA:25%; MSE:25%; ESE:50%	
	Text book/s*	1. Kanti Swarup, P.K. Gupta, Man Mohan, Operations Research, Sultan Chand & Sons. 2. S. Chandra, Jayadeva, Aparna Mehra, Numerical Optimization with Applications, Narosa.	
	Other References	1 Hamdy A. Taha, Operations Research, An Introduction, 9th Edition, Pearson. 2. M.S. Bazarra, H.D. Sheral, and C.M. Shetty, Nonlinear Programming Theory and Algorithms.	

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
BDA215.1	1	2	2	2	1	1	1	2	3		1			1
BDA215.2	1	2	3	2	1	1	1	2	3		1			1
BDA215.3	1	2	2	2	1	1	1	2	3		1			1
BDA215.4	1	2	3	3	1	1	1	2	3		1			1
BDA215.5	1	2	2	2	1	1	1	2	3		1			1
BDA215.6	1	2	2	2	1	1	1	2	3		1			1
Average	**1.0**	**2.0**	**2.3**	**2.1**	**1.0**	**1.0**	**1.0**	**2.0**	**3.0**		**1.0**			**1.0**

Add Indian Language (2 credits)

School: SSBSR		Batch: 2024-28	
Programme: B.Sc. (Hons./Hons. With Research) Mathematics		Academic Year: 2025-26	
Branch: Mathematics		Semester: III	
1	Course Code	**AI3407**	
2	Course Title	Prompt Engineering for AI and Data Science	
3	Credits	2	
4	Contact Hours (L-T-P)	0-0-4	
	Course Status	DSE	
5	Course Objective	This course introduces the basics of AI prompting, including different types of prompts and how to structure them for better responses. Students will learn key techniques like providing context, refining prompts, and handling multi-turn conversations. The course also explores real-world applications in content creation, coding, and automated data analysis while addressing ethical considerations. By the end, students will be able to craft effective prompts and understand AI's role in various domains.	
6	Course Outcomes	**CO1**: Understand the basics of AI prompting and different types of prompts. **CO2**: Learn how to structure prompts effectively for better AI-generated responses. **CO3**: Apply advanced techniques like Chain-of-Thought prompting and multi-turn conversations. **CO4**: Explore real-world applications of AI prompting in content creation, coding, and automated data analysis. **CO5**: Identify ethical considerations and biases in AI-generated content. **CO6**: Develop the ability to craft optimized prompts for various industries and future AI trends.	
7	Course Description	This course provides a foundational understanding of AI prompting, teaching students how to effectively communicate with AI models to generate accurate and useful responses. It covers different types of prompts, key strategies for refining AI outputs, and advanced techniques like Chain-of-Thought prompting. Practical applications in content creation, coding, and business automation are explored, along with ethical considerations. By the end of the course, students will be able to craft effective prompts for various real-world scenarios.	
8	Outline syllabus		CO Mapping
	Unit 1	**Introduction to Prompting**	
	A	What is prompting and understanding AI models (GPT, LLMs, Transformers)	CO1, CO2
	B	Types of prompts (Instructional, Open-ended, Role-based), Basic prompt structures	CO1, CO2
	C	Importance of effective prompts	CO1, CO2

	Case Study	**Using AI for Customer Support:** How well-structured vs. poorly structured prompts impact AI responses in customer service chatbots.			
	Unit 2	**Fundamentals of Effective Prompting**			
	A	Clarity and specificity in prompts, Role of context and constraints			CO4
	B	Importance of examples in prompting			CO4
	C	Common mistakes in prompting			CO4
	Case Study	**AI in Content Writing:** How prompt refinement improves AI-generated articles, blog posts, and marketing copy.			
	Unit 3	**Advanced Prompting Techniques**			
	A	Chain-of-thought prompting (breaking down complex queries)			CO3
	B	Few-shot and zero-shot learning, Multi-turn conversation strategies			CO3
	C	Bias and ethical considerations in prompting, Prompt debugging techniques			CO3
	Case Study	**AI for Code Generation:** Comparing results of different prompts in generating Python/Java code using AI.			
	Unit 4	**Domain-Specific Prompting**			
	A	Prompting for different industries (Healthcare, Legal, Education, Marketing).			CO2
	B	AI-powered prompting to EDA, statistical queries, visualization, and report generation.			CO2
	C	Using AI for decision-making support, Fine-tuning AI responses for professional use.			CO2, CO5
	Case Study	**AI in Education:** How educators can use AI for generating lesson plans, quizzes, and explanations			
	Unit 5	**Real-World Applications & Future of Prompting**			
	A	AI-assisted research and writing			CO5
	B	Prompting in automation and AI agents, The role of prompt engineering in AI-driven products			CO5
	C	Future trends in AI prompting			CO6
	Case Study	***AI in Business Decision-Making:*** How companies use AI-generated insights for market analysis and strategic planning			
	Mode of examination	Practical			
	Weightage	CA	CE	ESE	

	Distribution	30%	30%	40%	
	Text book/s*				
	Other References				

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
AI3407.1	3	3	2	2	2	3	2	2	1	1
AI3407.2	2	3	3	3	3	2	1	2	2	2
AI3407.3	2	3	2	1	2	2	2	1	2	2
AI3407.4	2	2	2	3	2	2	1	2	2	2
AI3407.5	3	2	2	3	2	2	2	2	2	1
AI3407.6	3	3	2	2	3	3	2	2	2	2
Average	**2.5**	**2.7**	**2.2**	**2.3**	**2.3**	**1.7**	**1.8**	**1.8**	**1.7**	**1.7**

School: SSBSR		**Batch: 2024-28**	
Programme: B.Sc. (Hons./Hons. With Research) Mathematics		**Academic Year: 2025-26**	
Branch: Mathematics		**Semester: III**	
1	Course Code	**CMS251**	
2	Course Title	**Calculus Lab**	
3	Credits	2	
4	Contact Hours(L-T-P)	0-0-4	
	Course Status	CC	
5	Course Objective	1. To familiarize the students with basic concepts of the fundament mathematical concepts for MATLAB. The course will cover the syntax and semantics of MATLAB including control structures, comments, variables, functions etc. 2. To understand the basic concept of the language have been established students will explore different types of scientific programming problems including curve fitting, ODE solving etc.	
6	Course Outcomes	The Students will be able to: CO1: Describe the fundamentals of MATLAB and use MATLAB for interactive computations. (K1, K2, K3,K4) CO2: Determine Limit and Differentiation (K1, K2, K3) CO3: Illustrate basic of Asymptotes of the algebraic curves and curve tracing (k2,K3) CO4: To Create plots and export this for use in reports and presentations. (K2,K3, K5) CO5: Develop program scripts and functions using the MATLAB development environment. (k3, K4, K5) CO6: To discuss the partial Differential equation and the concept of Multiple Integrals.(K5,K6)	
7	Course Description	This course is an introduction to the basic understanding the fundamental mathematical concepts for MATLAB. The course will cover the syntax and semantics of MATLAB including control structures, comments, variables, functions etc.	
8	**Outline syllabus**		**CO Mapping**
	Unit 1		
	A,B,C	Limit and Differentiation Taylor's theorem and Maclaurin's theorem, Maxima-minima and Points of inflexion.	CO1
	Unit 2		
	A,B,C	Partial differentiation and Euler's theorem. Maxima-minima in two variables Lagrange's multipliers method	CO2
	Unit 3		
	A,B,C	Asymptotes of the algebraic curves parallel asymptotes Curve tracing-Cartesian	CO3

	Unit 4	**USING MATLAB**	
	A,B,C	Evaluation of double integrals Change of order of integration change of variables	CO4,CO5
	Unit 5		
	A,B,C	Evaluation of triple integrals Volume and Surfaces Volume of a cylinder	CO5,CO6
	Mode of examination	Lab	
	Weightage Distribution	CA:30%; CE:30%; ESE:40%	
	Text book/s*	1. An introduction to MATLAB : Amos Gilat	
	Other References	1. Applied Numerical Methods with Matlab for engineering and Scientists by stevenchapra, Mcgraw Hill.	

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CMS251.1	2	2	2	2		1	1	3	1	1	1	1	2	
CMS251.2	2	2	3	2		1	1	3	1	1	1	1	2	
CMS251.3	2	2	2	2		1	1	3	1	1	1	1	2	
CMS2514	2	2	2	2		1	1	3	1	1	1	1	2	
CMS251.5	2	2	2	2		1	1	3	1	1	1	1	2	
CMS251.6	2	2	2	2		1	1	3	1	1	1	1	2	
Average	**2.0**	**2.0**	**2.0**	**2.0**		**1.0**	**1.0**	**3.0**	**1.0**	**1.0**	**1.0**	**1.0**	**2.0**	

School: SSBSR		**Batch: 2024-28**	
Programme: B.Sc. (Hons./Hons. With Research) Mathematics		**Academic Year: 2025-26**	
Branch: Mathematics		**Semester: III**	
1	Course Code	**VOM2305**	
2	Course Title	**DATA VISUALIZATION WITH TABLEAU AND POWER BI**	
3	Credits	3	
4	Contact Hours (L-T-P)	0-0-6	
	Course Status	SEC	
5	Course Objective	1.To use advanced formula techniques and sophisticated lookups 2.To distinguish between different functions, to understand the pitfalls and strengths of commonly used functions, and to apply correct functions to their Excel models.	
6	Course Outcomes	CO1: Select functionalities like Goal Seek, Data Tables and the Scenario Manager to make your models more robust and identify uses of macros. CO2: Explain creating and maintaining accurate, flexible, responsive and user-friendly spreadsheets. CO3: Construct automated tasks using functions, and make sure the data stays clean dynamically. CO4: Examine array capabilities and explores a range of functions to create dynamic lookup ranges. CO5: Explain data through graphs and charts, create data models, and add interactivity. CO6: Create visualizations to analyze and present data.	
7	Course Description	In offices all throughout the world, spreadsheet software continues to be one of the most frequently used programs. A significant tool will be added to your employability profile after you learn to use this software with assurance. Every day, there are millions of job postings in India alone that mention having Excel abilities. Digital skills contribute to higher income and better employment chances.	
8	**Outline syllabus**		**CO Mapping**
	Unit 1	**Data Modeling and Macros**	
	A	Modelling Functions: SUMPRODUCT	CO1
	B	Data Tables, Goal Seek, Scenario Manager, Solver.	CO1
	C	Record a Macro, Run a Macro, Edit a Macro, Working with Macros, Relative Reference Macros	CO1
	Unit 2	**Spreadsheet Design and Documentation**	
	A	Spreadsheet Design Principles	CO2
	B	Calculations, Interface and Navigation	CO2
	C	Tables and Structured Referencing, Using Functions to Sort Data, Introduction to Array Formulas, Working with an Array Function (TRANSPOSE), Solving Problems with Array Formulas.	CO2
	Unit 3	**Data Cleaning and Preparation**	
	A	Replace blanks with repeating values	CO3
	B	Fix Dates (DATE, MONTH, YEAR, DAY, TEXT)	CO3

	C	Remove Unwanted Spaces (TRIM, CLEAN), Diagnostic Tools (ISNUMBER, LEN, CODE), Remove Unwanted Characters (SUBSTITUTE, CHAR, VALUE)	CO3
	Unit 4	**Building Professional Dashboards using Financial Functions and Advanced Lookups**	CO4
	A	Working with Dates (EOMONTH, EDATE, WORKDAY.INTL), Financial Functions (FV, PV, PMT), Loan Schedule (PMT, EDATE), Net Present Value and Internal Rate of Return (NPV, IRR), Depreciation Functions (SLN, SYD, DDB).	CO4
	B	INDIRECT, ADDRESS, Introduction to OFFSET, Solving Problems with OFFSET.	CO4
	C	Dashboard Design, Prepare Data, Construct Dashboard, Creative Charting, Interactive Dashboard	CO5
	Unit 5	**Data Analysis**	
	A	Correlation, Histogram, Multiple Correlation	CO5
	B	Regression, ANOVA, Rank and Percentile	CO6
	C	Sampling, t-test, z-test	CO6
	Mode of examination	Practical Based	
	Weightage Distribution	CA:30%; MSE:30%; ESE:40%	
	Text book/s*	1. Michael Alexander, Excel® Dashboards & Reports For Dummies, John Wiley & Sons, Inc, ISBN: 978-1-119-07676-6, 2016.	
	Other References	1. Michael Alexander and Dick Kusleika, Excel 2016 Formulas, John Wiley & Sons, Inc, ISBN: 978-1-119-06786-3, 2016.	

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
VOM2305.1		3	3	2		1	1	3	1		2		1	
VOM2305.2		3	3	2		1	1	3	1		2		1	
VOM2305.3		3	3	2		1	1	3	1		2		1	
VOM2305.4		3	3	2		1	1	3	1		2		1	
VOM2305.5		3	3	2		1	1	3	1		2		1	
VOM2305.6		3	3	2		1	1	3	1		2		1	
Average		**3.0**	**3.0**	**2.0**		**1.0**	**1.0**	**3.0**	**1.0**		**2.0**		**1.0**	

School: SSBSR		**Batch: 2024-28**	
Programme: B.Sc. (Hons./Hons. With Research) Mathematics		**Academic Year: 2025-26**	
Branch: Data Science & Analytics		**Semester: III**	
1	Course Code	**MTR2351**	
2	Course Title	**Research Based Learning-I**	
3	Credits	00	
4	Contact Hours (L-T-P)	0-0-2	
	Course Status	Project	
5	Course Objective	Deep knowledge of a specific area of specialization. Develop communication skills, especially in project writing and oral presentation. Develop time management skills.	
6	Course Outcomes	CO1: Understand the basics of software and programs used during research for effective writing and presentation. (K1) CO2: Demonstrate the knowledge of a program best suited for mathematics. (K1, K2) CO3: Construct and develop a deeper interest in mathematics and a taste for research. (K3, K4) CO4: Determine effective project organizational skills. (K5) CO5: Analyse the problem and summarize research findings and present. (K4, K5) CO6: Formulate the research findings to develop education theory and practice. (K3, K6)	
7	Course Description	Maintain a core of mathematical and technical knowledge that is adaptable to changing technologies and provides a solid foundation for future learning.	
8			
	Unit 1	**Introduction to word**	**CO1**
		Introduction to basics of fonts, alignments, layout and design. Inserting tables and images.	
	Unit 2	**Introduction to Latex**	**CO1, CO2**
		Student learns basic syntax and writes equations. Learns to insert matrix, tables and images. Writing references.	
	Unit 3	**Information Collection and Feasibility Analysis of the Identified Problem**	**CO3, CO4**
		Student collects information from multiple sources and analyzes the information in-depth, also checks the feasibility.	
	Unit 4	**Appropriateness of Problem Title**	**CO4, CO5**
		Title is clearly defined and the context for the research provided	
	Unit 5	**Literature Review of Problem Domain**	**CO5, CO6**
		To review the research papers from various databases (Scopus, Taylor Francis, Springer, etc.)	
	Mode of examination	Project	
	Weightage Distribution	CA: 30%; CE: 30%; ESE: 40%	
	Text book/s*	Research Methodology by C R Kothari; A Beginners Guide To Research Methodology by Ashreet Acharya and Abhipsa Anamika	
	Other References		

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
MTR2351.1		2	1	2	2	1		3			2	2	2	2
MTR2351.2		2	1	2	2	1		3			2	2	2	2
MTR2351.3		2	1	2	2	1		3			2	2	2	2
MTR2351.4		2	1	2	2	1		3			2	2	2	2
MTR2351.5		2	1	2	2	1		3			2	2	2	2
MTR2351.6		2	1	2	2	1		3			2	2	2	2
Average		**2.0**	**1.0**	**2.0**	**2.0**	**1.0**		**3.0**			**2.0**	**2.0**	**2.0**	**2.0**

School: SSBSR		Batch: 2024-28	
Programme: B.Sc. (Hons./Hons. With Research) Mathematics		Academic Year: 2025-26	
Branch: Mathematics		Semester: IV	
1	Course Code	CMS231	
2	Course Title	Real Analysis	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
	Course Status	CC	
5	Course Objective	To make students familiar with the basic concepts of real analysis. The notion of limit, continuity, differentiability, sequences, infinite series & their convergence has been also introduced.	
6	Course Outcomes	**CO1:** Discuss the basic concepts of set theory on R, open & closed sets, bounded & unbounded sets, countable & uncountable sets and calculate the limit points of sets. (K2, K3) **CO2:** Describe the concept of Limit, Continuity, and Continuous & Discontinuous functions, Uniform continuous functions and calculate same. (K2, K3) **CO3:** Define the definition of derivatives, increasing & decreasing functions, explain Darboux's theorem, Rolle's theorem, Mean Value Theorem & its applications. (K1, K4) **CO4:** Calculate and analyze the convergent sequences, limit point of sequence, non-convergent sequence, and monotonic sequences. (K3,K4) **CO5:** Explain the concept of series and illustrate the test for series.(K2, K3, K4) **CO6:** Evaluate Positive terms series, Alternating series, Series with arbitrary terms. (K6)	
7	Course Description	This is an introductory course of real analysis. Students are introduced to the fundamental concepts of real analysis. The notion of limit, continuity, differentiability, sequences, infinite series & their convergence has been also introduced.	
8	**Outline syllabus**		**CO Mapping**
	Unit 1	**ELEMENTS OF POINTS SET THEORY ON R**	
	A	Sets, Intervals: Open and closed, Bounded and unbounded sets, Supremum and infimum.	CO1
	B	Neighborhood of a point, Open and Closed sets, Limits points of a set, Bolzano – Weierstrass Theorem (statement)	CO1
	C	Countable and Uncountable sets	CO1
	Unit 2	**LIMIT & CONTINUITY OF FUNCTIONS ON R**	
	A	Limit of a function, Theorems on algebra of limits, Limit or a function	CO2
	B	Sequential approach, Cauchy's criteria for finite limits	CO2
	C	Continuous functions, Discontinuous functions, Properties of continuous functions on closed intervals, Uniform continuous functions and related Results	CO2
	Unit 3	**DIFFERENTIATION OF FUNCTIONS ON R**	
	A	Definitions of derivatives and related results, increasing and decreasing functions	CO3

	B	Darboux's theorem, Rolle's Theorem,	CO3
	C	Mean value theorems of differential calculus and their applications	CO3
	Unit 4	**SEQUENCES**	
	A	Sequences, Bounded and convergent sequences	CO4
	B	Limit Points of a sequence, Bolzano – Weierstrass Theorem, Limit inferiorand superior,	CO4
	C	Non-convergent (divergent) sequence, Cauchy's general principle ofconvergence, monotonic sequences.	CO4
	Unit 5	**INFINTE SERIES & THEIR CONVERGENCE**	
	A	Series of positive terms: p- test, the comparison, Cauchy's root and D' Alembert ratio tests (without proof), Logarithmic and Integral test	CO5, CO6
	B	Alternating series, Leibnitz test, absolute and conditional convergence	CO5, CO6
	C	Series of arbitrary terms, Abel's and Dirichlet's tests.	CO5, CO6
	Mode of examination	Theory	
	Weightage Distribution	CA:25%; MSE:25% ESE:50%	
	Text book/s*	1. Rudin, Walter, Principles of Mathematical Analysis, third edition, InternationalSeries in Pure and Applied Mathematics. McGraw-Hill Book Co., New York-Auckland-D usseldorf, 1976.	
	Other References	1. T. M. Apostol, Mathematical Analysis, Narosa Publishing House, NewDelhi, 1985. 2. S.C. Malik and Savita Arora: Mathematical Analysis, Second Edition, Wiley Eastern Limited, New Age International Limited, New Delhi, 1994.	

COURSE OUTCOMES – PROGRAMMEME OUTCOMES MAPPING TABLE

PO / CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
CMS231.1	2	2	2	2	2	3	2	3	3
CMS231.2	2	2	2	2	3	2	3	3	2
CMS231.3	2	2	2	2	3	3	3	3	3
CMS231.4	2	2	2	2	2	3	2	3	2
CMS231.5	2	2	2	3	3	3	3	3	3
CMS231.6	2	2	2	3	3	3	3	3	3

School: SSBSR		Batch: 2024-28	
Programme: B.Sc. (Hons./Hons. With Research) Mathematics		Academic Year: 2025-26	
Branch: Mathematics		Semester: IV	
1	Course Code	CMS232	
2	Course Title	Ordinary Differential Equations and Laplace Transforms	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
	Course Status	CC	
5	Course Objective	1. To understand the basic concept of differential equations, formation of differential equations, solution of first and higher order differential equations and their applications. 2. To understand the basic concept of Laplace Transforms and solution of differential equations using Laplace Transforms.	
6	Course Outcomes	The student will be able to CO1: understand the basic of differential equations (DE) and solution of first order and first degree DE. (K1, K2, K3) CO2: find the solution of first order but not of first degree DE and higher order DE. (K1, K2, K3) CO3: learn the different methods of finding the solution of DE. (K2, K3,K4) CO4: find the solution of simultaneous DE and other methods. (K3, K4) CO5: learn the basic of Laplace Transform and its properties. ,(K4, K5) CO6: find the solution of DE using Laplace Transform. (K3, K4, K5, K6)	
7	Course Description	This course is an introduction to the fundamental of Differential Equations and Laplace Transforms. The primary objective of thecourse is to develop problem solving skills for solving various types of differential equation using different methods and also with the help of Laplace Transforms.	
8	**Outline syllabus**		**CO Mapping**
	Unit 1	**Differential Equations I**	
	A	Formation of differential equations, Geometrical meaning of a differential equation,Equation of first order and first degree.	CO1
	B	Equation in which the variables are separable, Homogeneous equations.	CO1
	C	Linear equations and equations reducible to the linear form.	CO1
	Unit 2	**Differential Equations II**	
	A	Exact differential equations and equations reducible to the exact form.	CO2
	B	First order higher degree equations solvable for x, y, p, Clairaut's equation and singular solutions, orthogonal trajectories.	CO2
	C	Homogeneous and Non-homogeneous Linear differential equation with constant coefficients.	CO2, CO3
	Unit 3	**Differential Equations III**	
	A	Method of Variation of parameters, Reduction of order.	CO3, CO6
	B	Method of undetermined coefficients, Cauchy- Euler form.	CO3, CO4
	C	Ordinary Simultaneous Differential Equations.	CO3, CO4

	Unit 4	**Laplace Transforms I**	
	A	Laplace Transform: Definition and its properties, Linearity and First Shifting Theorem.	CO4, CO5
	B	Laplace Transforms of Derivatives and Integrals.	CO5
	C	Introduction to Inverse Laplace Transform and its properties,	CO5
	Unit 5	**Laplace Transforms II**	
	A	Convolution Theorem and its application.	CO5, CO6
	B	Solution of Initial Value Problem using Linear Transform.	CO5, CO6
	C	The Heaviside Function, The Unit Pulse Function, Second Shifting Theorem.	CO5
	Mode of examination	Theory	
	Weightage Distribution	CA:25%; MSE:25% ESE:50%	
	Text book/s*	1.) S. L. Ross, Differential Equations, 3rd Edition, Wiley.	
	Other References	1.) D.A. Murray, Introductory Course in Differential Equations, Orient Longm. 2.) M. Spiegel, Schaum's Outline of Laplace Transforms.	

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO **CO**	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PSO 1**	**PSO 2**	**PSO 3**
CMS232.1	3	3	2	2	2	1					2	2		
CMS2321.2	2	3	2	2	2	1					2	2		
CMS232.3	3	3	2	3	2	1					2	2		
CMS232.4	2	3	3	3	2	1					2	2		
CMS232.5	2	3	3	3	2	1					2	2		
CMS232.6	3	3	3	3	2	1					2	2		
Average	**2.0**	**3.0**	**2.5**	**2.6**	**2.0**	**1.0**					**2.0**	**2.0**		

School: SSBSR		Batch: 2024-28	
Programme: B.Sc. (Hons./Hons. With Research) Mathematics		Academic Year: 2025-26	
Branch: Mathematics		Semester: IV	
1	Course Code	MSM306	
2	Course Title	Mechanics	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
	Course Status	CC	
5	Course Objective	Familiarise students with basic concepts of mechanics. Give an idea of the Hook's Law. Given an understanding of a constrained motion, motion in a resisting medium. Discuss the concept of uniform catenary, centre of Gravity.	
6	Course Outcomes	CO1: Explain the concept of velocity acceleration along coordinate Axes. Discuss the concept of relation between angular and linear velocities, equation of motion. (K2, K4) CO2: motion under inverse square law and explain motion of a particle under the attraction of the earth, simple harmonic motion, Hooke's Law. (K3) CO3: Explain the use of constrained motion and evaluate motion on the outside of a smooth vertical circle. (K2, K3, K4) CO4: Motion on a rough curve under gravity, Explain the motion in a resisting medium and planetary motion. (K2, K4,K5) CO5: Describe the uniform catenary and explain tightly stretched string and approximations to a catenary. (K1, K2, K4) CO6: Understand and evaluate centre of gravity of an arc, of a plane area, of a solid of revolution, of surface of revolution. (K2, K6)	
7	Course Description	This course will cover the basic concepts of mechanics. Give an idea of the Hook's Law. Given an understanding of a constrained motion, motion in a resisting medium. Discuss the concept of uniform catenary, centre of Gravity.	
8	Outline syllabus		CO Mapping
	Unit 1		
	A	Velocity and acceleration along coordinate Axes in two dimensions, radial and transverse directions, and along tangential and normal direction	CO1, CO2
	B	Relation between angular and linear velocities, equation of motion, motion under inverse square law	CO1, CO2
	C	Motion of a particle under the attraction of the earth, Simple harmonic motion, Hooke's Law.	CO1, CO2
	Unit 2		
	A	Constrained motion: motion in a smooth vertical circle,	CO3
	B	motion in inside of a smooth fixed hollow sphere from its lowest point,	CO3
	C	Motion on the outside of a smooth vertical circle, motion on a rough curve under gravity.	CO3
	Unit 3		

A	Motion in a resisting medium: motion of a particle falling under gravity	CO4
B	Motion of a particle projected vertically upwards	CO4
C	Planetary Motion: Newton's law of gravitation, motion under the inverse square law, Kepler's laws of planetary motion.	CO4
Unit 4		
A	A uniform catenary, Intrinsic equation of the common catenary.	CO5
B	Cartesian equation of the common catenary,	CO5
C	Tightly stretched string and approximations to a catenary,	CO5
Unit 5		
A	Centre of Gravity: Centre of Gravity of an arc,	CO6
B	Of a plane area, of a solid of revolution,	CO6
C	Of surface of revolution.	CO6
Mode of examination	Theory	
Weightage Distribution	CA:25%; MSE:25% ESE:50%	
Text books	1. Synge and Griffith: Principle of Mechanics.	
Other references	1. S.L. loney: Dynamics of particles and rigid bodies.	

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
MSM306.1	2	3	1	1		1						2		
MSM306.2	2	2	3	2		1						2		
MSM306.3	2	2	1	1		1						2		
MSM306.4	2	2	3	1		1						1		
MSM306.5	3	2	3	1		1						3		
MSM306.6	3	1	1	1		3						2		
Average	**2.3**	**2**	**1.6**	**1.8**		**1.3**						**2**		

School: SSBSR		**Batch: 2024-28**	
Programme: B.Sc. (Hons.)		**Academic Year: 2025-26**	
Branch: Mathematics		**Semester: IV**	
1	Course Code	**MTP2451**	
2	Course Title	**Ordinary Differential Equations and Laplace Transforms Lab**	
3	Credits	2	
4	Contact Hours (L-T-P)	0-0-4	
	Course Status	CC	
5	Course Objective	1. To familiarize the student in introducing and exploring MATLAB software. 2. To enable the student on how to approach for solving problems of Differential Equations using MATLAB tools. 3. To understand the use of MATLAB in Laplace Transforms. 4. To prepare the students to use MATLAB in their project works. 5.To provide a foundation in use of this software for real time applications.	
6	Course Outcomes	The student will be able to write a code in Mathematica /MATLAB /Maple /Scilab/Maxima CO1: to find the solution of first order Differential Equations. (K1, K2, K3) CO2: to find the solution of higher order linear Differential Equations with constant coefficient. (K1, K2, K3) CO3: to solve the Differential Equations using method of variation of parameter, Cauchy-Euler form and also find the solution of ordinary simultaneous Differential Equations. (K2, K3) CO4: to explore the concept of Laplace Transforms with the help of MATLAB. (K3, K4, K5) CO5: to apply the concept of MATLAB for finding the Laplace Transform of derivatives and Integrals. (K4, K5, K6) CO6: to discuss the solution of Initial value problem using Laplace Transform. (K4, K5, K6)	
7	Course Description	The course is an introduction to the MATLAB in Differential Equations and Laplace Transforms. The primary objective of the course is to develop basic mathematical modelling and to solve various equations using MATLAB.	
8	**Outline syllabus**		**CO Mapping**
	Unit 1	**First order Differential equation**	
	A, B, C	1.) Solution of first order and first-degree Differential Equations, 2.) Solution of first order and first-degree Differential Equations with initial conditions. 3.) Solution of first order but not of first-degree Differential Equations. 4.) Solution of first order but not of first-degree Differential Equations with initial conditions.	CO 1
	Unit 2	**Higher order ODE**	
	A, B, C	5.) Higher order linear Differential Equations with constant coefficient. 6.) Higher order linear Differential Equations with constant coefficient with initial conditions.	CO 2
	Unit 3	**Simultaneous ODE**	
	A, B, C	7.) Method of Variation of parameters, 8.) Cauchy-Euler form of Differential Equations, 9.) Ordinary Simultaneous Differential Equations. 10.) Ordinary Simultaneous Differential Equations with initial conditions.	CO 3, CO 6
	Unit 4	**Laplace Transforms**	
	A, B, C	11.)Laplace Transforms and Inverse Laplace Transforms,	CO 4

		12.)Laplace transforms of Derivatives, 13.)Laplace Transforms of Integrals.	
	Unit 5	**Application of Laplace Transform**	
	A, B, C	14.) Solution of Initial Value Problem using Laplace Transform.	CO 5, CO 6
	Mode of examination	Practical + viva	
	Weightage Distribution	CA:30%; CE:30%; ESE:40%	
	Text book/s*	1. Rizwan Butt, An introduction to Differential Equations using MATLAB, Alpha Science International Ltd., 2016	
	Other References	1 Applied Numerical Methods with MATLAB for engineering and Scientists by stevenchapra, Mcgraw Hill.	

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
MTP2451.1	3	3	2	3	1	1	1	3	1	1	2	1	2	
MTP2451.2	3	3	2	3	1	1	1	3	1	1	2	1	2	
MTP2451.3	3	3	2	3	1	1	1	3	1	1	2	1	2	
MTP2451.4	3	3	2	3	1	1	1	3	1	1	2	1	2	
MTP2451.5	3	3	2	3	1	1	1	3	1	1	2	1	2	
MTP2451.6	3	3	2	3	1	1	1	3	1	1	2	1	2	
Average	**3.0**	**3.0**	**2.0**	**3.0**	**1.0**	**1.0**	**1.0**	**3.0**	**1.0**	**1.0**	**2.0**	**1.0**	**2.0**	

School: SSBSR		**Batch: 2024-28**	
Programme: B.Sc.(Hons./Hons. With Research)		**Academic Year: 2025-26**	
Branch: Mathematics		**Semester: IV**	
1	Course Code	**AI3408**	
2	Course Title	Supervised & Unsupervised Learning Techniques	
3	Credits	3	
4	Contact Hours (L-T-P)	0-0-6	
	Course Status	Minor	
5	Course Objective	This course aims to introduce students to the fundamentals of data science by exploring both supervised and unsupervised learning techniques. It provides hands-on experience in data preprocessing, feature engineering, model training, evaluation, and optimization using Python. Students will develop programming and analytical skills, apply key mathematical concepts such as linear algebra, probability, and optimization, and gain insights into building effective machine learning models for real-world data science applications.	
6	Course Outcomes	**CO1**: Apply data preprocessing techniques to real-world datasets for exploratory data analysis and model readiness. **CO2**: Implement and evaluate supervised and unsupervised learning models. **CO3**: Analyze model performance using various evaluation metrics. **CO4**: Optimize models using hyperparameter tuning techniques. **CO5**: Understand advanced supervised and unsupervised learning techniques for structured/tabular data **CO6**: Develop problem-solving skills using machine learning techniques in various domains.	
7	Course Description	This lab course covers the basics of supervised and unsupervised learning. Students will learn how to apply machine learning algorithms using Python. The lab focuses on hands-on experience with data preprocessing, model training, evaluation, and optimization, helping students understand machine learning concepts and solve real-world problems.	
8	Outline syllabus		CO Mapping
	Unit 1	**Introduction to Machine Learning**	
	A	Introduction to Python Libraries: NumPy, Pandas, Matplotlib, and Scikit-learn.	CO1
	B	Data Preprocessing Techniques: Handling missing values, feature scaling, and encoding categorical variables.	CO1

	C	Exploratory Data Analysis (EDA): Visualizing and understanding datasets using statistical methods.			CO2
	Unit 2	**Supervised Learning Techniques**			
	A	Implementing Linear Regression: Predicting house prices using a dataset.			CO2
	B	Logistic Regression: Classification of spam emails			CO2
	C	Decision Trees, Random Forest, Support Vector Machines (SVM).			CO3
	Unit 3	**Unsupervised Learning Techniques**			
	A	K-Means Clustering: Customer segmentation in retail data.			CO2
	B	Hierarchical Clustering: Clustering gene expression data.			CO3
	C	Principal Component Analysis (PCA): Dimensionality reduction of high-dimensional data.			CO4
	Unit 4	**Model Evaluation and Optimization**			
	A	Cross-validation and Model Performance Metrics: Accuracy, Precision, Recall, F1-score.			CO4
	B	Hyperparameter Tuning: Grid Search and Randomized Search.			CO4
	C	Bias-Variance Tradeoff: Understanding overfitting and underfitting in mode			CO5
	Unit 5	**Applications of Supervised and Unsupervised Learning in Real-World Scenarios**			
	A	Predictive analytics (e.g., stock price prediction, weather forecasting etc).			CO5
	B	Healthcare applications (e.g., disease classification, medical diagnosis, etc).			CO6
	C	Fraud detection in banking (e.g., credit card fraud detection). Case study discussions on ethical AI and bias in ML models.			CO6
	Mode of examination	Practical			
	Weightage Distribution	CA	CE	ESE	
		30%	30%	40%	
	Text book/s*				
	Other References				

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PSO 1	PSO 2	PSO 3
AI3408.1	2	1	2	2	1	2	3	2	2	2	2	2	2	2
AI3408.2	2	1	2	2	1	2	3	2	2	2	2	2	2	2
AI3408.3	2	1	2	2	1	2	3	2	2	2	2	2	2	2
AI3408.4	2	1	2	2	1	2	3	2	2	2	2	2	2	2
AI3408.5	2	1	2	2	1	2	3	2	2	2	2	2	2	2
AI3408.6	2	1	2	2	1	2	3	2	2	2	2	2	2	2
Average	**2**	**1**	**2**	**2**	**1**	**2**	**3**	**2**	**2**	**2**	**2**	**2**	**2**	**2**

<table>
<tr><td colspan="2">School: SSBSR</td><td colspan="3">Batch: 2024-28</td></tr>
<tr><td colspan="2">Programme: B.Sc. (Hons./Hons. With Research) Mathematics</td><td colspan="3">Academic Year: 2025-26</td></tr>
<tr><td colspan="2">Branch: Mathematics</td><td colspan="3">Semester: IV</td></tr>
<tr><td>1</td><td>Course Code</td><td colspan="3">CCU108</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">2</td></tr>
<tr><td>4</td><td>(L-T-P)</td><td colspan="3">0-0-4</td></tr>
<tr><td></td><td>Course Status</td><td colspan="3">AEC</td></tr>
<tr><td>5</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>6</td><td>Course Objectives</td><td colspan="3">1. Contribute to the holistic development of students by making them more aware of socially and economically disadvantaged communities and their specific issues
2. Provide richer context to classrooms, to make them more effective laboratories of learning by aligning them to social realities beyond textbooks
3. Provide scope to faculty members to align their teaching and research goals by giving them ample opportunity to carry out community-oriented projects
4. Ensure that the community connect programs provides benefits to communities in tangible ways so that they may feel perceptibly better off post the interaction and involvement of the Sharda academic community
5. Provide ample opportunity for Sharda University academic community to contribute effectively to society and nation building</td></tr>
<tr><td>7</td><td>Course Outcomes</td><td colspan="3">After completion of this course, students will be able to:
CO1: Students learn to be sensitive to the living challenges of disadvantaged communities.
CO2: Students learn to appreciate societal realities beyond textbooks and classrooms
CO3: Students learn to apply their knowledge via research, and training for community benefit
CO4: Students learn to work on socio-economic projects with teamwork and timely delivery
CO5: Students learn to engage with communities for meaningful contributions to society.
CO6: The survey will help to identify the gaps and create a plan to further</td></tr>
</table>

		improve the situation related to social problems prevailing in different sections of society and find the solution in a sustainable manner.
8	**Theme**	**Major research themes:** 1. ***Survey and self-learning***: In this mode, students will make the survey, analyze data, and will extract results to correlate with their theoretical knowledge. E.g. Crops and animals, land holding, labor problems, medical problems of animals and humans, savage and sanitation situations, waste management, etc. 2. ***Survey and solution providing***: In this mode, students will identify the common problems and will provide solutions/ educate the rural population. E.g. air and water pollution, the need for treatment, use of renewable (mainly solar) energy, electricity-saving devices, inefficiencies in the 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 analyzed 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 Program, BetiBachao, BetiPadhao 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.
9.1	**<u>Guidelines for Faculty Members</u>**	It will be a group assignment. There should be no 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-designed 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. **A plagiarism check of the report must**.

		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.
9.5	**Format:**	The report should be Spiral/ hardbound The Design of the Cover page to report will be given by the Coordinator- CCC Cover page Acknowledgement Content Project report Appendices
9.6	**Important Dates:**	Students should prepare questionnaire and get it approved by concern faculty member and submit the final questionnaire within ……..to CCC-Coordinator. Students will complete their survey work within …….. and submit the same to concern faculty member. (Each group should complete 50 questionnaires) The student should show the 1st draft of the report to concern faculty member within …….. and submit the same to concern faculty member. Faculty members should give required inputs, so that students can improve their project work and make the final report submission on …….. The students should submit the hard copy and soft copy of the report to CCC-Coordinator signed by the faculty guide within ……. The students should submit the soft copy of the PPT to CCC-Coordinator signed by the faculty guide within ……. The final presentation will be organized on ……...
9.7	**ETE**	The students will be evaluated by panel of faculty members on the basis of their presentation on ……

10	**Course Evaluation**	
10.01	**Continuous Assessment**	**25%**
	Questionnaire design	
	Report Writing	
10.02	**ETE (PPT presentation)**	**75%**

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CCU108.1	1	2	2	3	3	2	3	3	3	2	1	2	2	3
CCU108.2	1	2	2	3	3	2	3	3	3	2	1	2	2	3
CCU108.3	1	2	2	3	3	2	3	3	3	2	1	2	2	3
CCU108.4	1	2	2	3	3	2	3	3	3	2	1	2	2	3
CCU108.5	1	2	2	3	3	2	3	3	3	2	1	2	2	3
CCU108.6	1	2	2	3	3	2	3	3	3	2	1	2	2	3
Average	**1.0**	**2.0**	**2.0**	**3.0**	**3.0**	**2.0**	**3.0**	**3.0**	**3.0**	**2.0**	**1.0**	**2.0**	**2.0**	**3.0**

School: SSBES		**Batch: 2025-29**	
Programme: B.Sc. (Hons./Hons. With Research) Mathematics		**Academic Year: 2025-26**	
Branch: Data Science & Analytics		**Semester: IV**	
1	Course Code	**MTR2452**	
2	Course Title	**Research Based Learning-II**	
3	Credits	01	
4	Contact Hours (L-T-P)	0-0-2	
	Course Status	Project	
5	Course Objective	The RBL project aims to identify gaps in existing literature to enhance understanding of the topic, followed by developing clear, measurable objectives that address the research problem.	
6	Course Outcomes	CO1: Locate the research gap for further understanding of the specific topic. (K4) CO2: Construct objectives related to the research problem. (K5, K6) CO3: Explain a clear methodology for the research. (K4, K6) CO4: Develop an effective plan for the research procedure. (K5) CO5: Construct a skeleton for the research paper. (K4, K5) CO6: Collection of data from various sources. (K3, K6)	
7	Course Description	This course equips students with essential research skills, focusing on identifying research gaps, formulating objectives, designing methodologies, and effectively communicating findings through writing and presentations. It emphasizes time management, data collection, and academic paper construction.	
8			
	Unit 1	**Research Gap**	**CO1, CO2**
		To find the research gaps in various research papers to develop a theoretical framework and research questions	
	Unit 2	**Formulation of Research Objectives**	**CO2, CO3**
		To frame the objective of the research paper with acquired knowledge to fill the research gap found	
	Unit 3	**Methodology**	**CO3, CO4**
		Clear description of methods, procedures and steps to be used for the research	
	Unit 4	**Planning & Preliminary Results**	**CO4, CO5**
		Detailed formulation of the flow of the research procedure	
	Unit 5	**Data Collection**	**CO5, CO6**
		To collect data from primary and secondary sources	
	Mode of examination	Project	
	Weightage Distribution	CA: 30%; CE: 30%; ESE: 40%	
	Text book/s*	Research Methodology by C R Kothari; A Beginners Guide To Research Methodology by Ashreet Acharya and Abhipsa Anamika	
	Other References		

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
MTR2452.1		2	1	2	2	1		3			2	2	2	2
MTR2452.2		2	1	2	2	1		3			2	2	2	2
MTR2452.3		2	1	2	2	1		3			2	2	2	2
MTR2452.4		2	1	2	2	1		3			2	2	2	2
MTR2452.5		2	1	2	2	1		3			2	2	2	2
MTR2452.6		2	1	2	2	1		3			2	2	2	2
Average		**2.0**	**1.0**	**2.0**	**2.0**	**1.0**		**3.0**			**2.0**	**2.0**	**2.0**	**2.0**

School: SBES		**Batch : 2024- 2028**	
Programme: B.Sc. (Hons./Hons. With Research) Mathematics		**Academic Year: 2026-27**	
Branch: Mathematics		**Semester: V**	
1	Course Code	MSM 301	
2	Course Title	Complex Analysis	
3	Credits	4	
4	Contact Hours (L-T-P)	3-1-0	
	Course Status	CC	
5	Course Objective	1. 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. 2. Students will study geometric properties of conformal mappings in the plane and their relations with analytic functions	
6	Course Outcomes	CO1: Calculate continuity, differentiability, analyticity of a function and analyse the derivative of a function. (K3, K4) CO2: Evaluate a contour integral using parameterization, fundamental theorem of calculus and Cauchy's integral formula (K3, K6) CO 3: Develop the Taylor's and Laurent's series of a function and evaluate its circle or annulus of convergence; (K5, K6) CO 4:Caculate the residue of a function and use the residue theory to evaluate a contour integral or an integral over the real line (K3, K6) CO 5: Demonstrate the understanding of conformal mappings and Construct conformal mappings between many kinds of domain. (K2, K5) CO 6: Recognize and assess the applications of complex variables. (K1, K6)	
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 functions and their limits, continuity, differentiability,	CO1
	B	Analytic function, The C-R equations and sufficient	CO1

		conditions for differentiability and analyticity	
	C	Harmonic functions and harmonic conjugates.	CO1
	Unit 2		
	A	Cauchy's theorem (with proof), Cauchy's integral formula and its applications	CO2
	B	Taylor's series, Laurent expansion of functions	CO3
	C	Singularities and its types, residues.	CO4
	Unit 3		
	A	Residue theorem, applications of residue theorem	CO4
	B	Evaluation of real definite integrals	CO4
	C	Integration around the unit circle and evaluation of some infinite real integrals.	CO4
	Unit 4		
	A	Transformations or mappings, some standard transformations	CO5
	B	Bilinear transformation, fixed point of a transformation	CO5
	C	Conformal transformation, Jacobian of a transformation and few special conformal mappings.	CO5
	Unit 5		
	A	Application of complex conjugate functions	CO6
	B	Flow problems and modelling.	CO6
	C	Flow problems and modelling.	CO6
	Mode of examination	Theory	
	Weightage Distribution	CA: 25% / MTE: 25% / ETE: 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

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PSO 1	PSO 2	PSO 3
MSM301. 1	2	1	2	2	1	2	3	2	2	2	2	2	2	2
MSM301. 2	2	1	2	2	1	2	3	2	2	2	2	2	2	2
MSM301. 3	2	1	2	2	1	2	3	2	2	2	2	2	2	2
MSM301. 4	2	1	2	2	1	2	3	2	2	2	2	2	2	2
MSM301. 5	2	1	2	2	1	2	3	2	2	2	2	2	2	2
MSM301. 6	2	1	2	2	1	2	3	2	2	2	2	2	2	2
Average	**2**	**1**	**2**	**2**	**1**	**2**	**3**	**2**	**2**	**2**	**2**	**2**	**2**	**2**

School: SSBSR		**Batch: 2024-28**	
Programme: B.Sc. (Hons./Hons. With Research) Mathematics		**Academic Year: 2026-27**	
Branch: Mathematics		**Semester: V**	
1	Course Code	**CMS302**	
2	Course Title	**Mathematical Modelling**	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
	Course Status	CC	
5	Course Objective	1. To develop systematic understanding of key aspects of modeling and simulation. 2. To demonstrate students with the capability to deploy established approaches accurately to analyze and solve and interpret real life problems using different Mathematical perspectives.	
6	Course Outcomes	The student will be able to CO1: understand the basic concept of mathematical modeling. CO2: understand the linear and functions and their applications to real life problem. CO3: to learn the Linear regression; modeling with exponential function. CO4: understand to analyze the polynomial function and their applications. CO5: to learn the different compartmental models. CO6: identify and develop research models from the verbal description of the real system.	
7	Course Description	This course is an introduction to mathematical modeling based on the use of elementary functions to describe and explore real-world phenomena and data. Linear, exponential, logarithmic, and polynomial function models are examined closely and are applied to real-world data in course assignments and projects and the numerical analysis. The goal of this course is to teach students to formulate, analyze, and solve mathematical models that represent real-world problems.	
8	**Outline syllabus**		**CO Mapping**
	Unit 1	**Introduction to Mathematical Modeling**	
	A	Mathematical models, modeling approaches, simulation models	CO1
	B	Model types, modeling for decision making	CO1
	C	Stochastic and deterministic models	CO1
	Unit 2	**Functions; Modeling with Linear Functions**	
	A	Linear functions with applications, Slope-intercept and point-slope forms	CO2
	B	Fitting linear models to data, Evaluating model error; the sum of squared errors	CO2
	C	Interpreting the correlation coefficient	CO2, CO6
	Unit 3	**Linear Regression; Modeling with Exponential Functions**	
	A	Fitting linear models to data	CO3
	B	Exponential growth functions with applications	CO3
	C	Exponential decay functions with applications	CO3,
	Unit 4	**Modeling with Polynomial Functions**	
	A	Quadratic functions with applications, Maxima and minima	CO4

		applications	
	B	Fitting quadratic models to data	CO4
	C	Polynomial functions of higher degree with applications	CO4, CO6
	Unit 5	**Compartmental Models**	
	A	Introduction to compartmental models	CO5
	B	Exponential decay, formulating the differential equation	CO5, CO6
	C	Lake pollution models, disease compartmental models	CO5
	Mode of examination	Theory	
	Weightage Distribution	CA:25%; MSE:25% ESE:50%	
	Text book/s*	1. Functions, Data, and Models, Gordon and Gordon, The Mathematical Association of America, 2010 (ISBN-10: 0-8838-5767-7; ISBN-13 978-0-88385-767-0).	
	Other References	1. Daniel P. Maki, Maynard Thompson, Mathematical Modeling with Computer Simulation, India Edition, Cengage Learning, 2011 ISBN-13: 978-81-315-1286-9.	

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CMS302.1	3	3	3	3		1						3		
CMS302.2	3	3	3	3		1						3		
CMS302.3	3	3	3	3		1						3		
CMS302.4	3	3	3	3		1						3		
CMS302.5	3	3	3	3		1						3		
CMS302.6	3	3	3	3		1						3		
Average	**3.0**	**3.0**	**3.0**	**3.0**		**1.0**						**3.0**		

School: SSBSR		**Batch: 2024-28**	
Programme: B.Sc. (Hons./Hons. With Research) Mathematics		**Academic Year: 2026-27**	
Branch: Mathematics		**Semester: V**	
1	Course Code	**CMS332**	
2	Course Title	**Introduction to Partial Differential Equations**	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
	Course Status	CC	
5	Course Objective	Familiarise students with basic concepts of partial differential equations and introduce students to how to solve linear Partial Differential with different methods. Learn to solve first-order partial differential equations and formation of PDEs. Explore the methods to solve Linear homogeneous and non-homogeneous PDEs with constant 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: Formulate the partial differential equations and to solve linear PDEs by using Lagrange's method. (K3, K5) CO2: Explain and use methods to solve Linear homogeneous PDE with constant coefficient. (K2, K3, K4) CO3: Describe the rules to find complimentary function and particular integral and apply in various cases. (K2, K4) CO4: Evaluate non- homogeneous linear PDE with constant coefficient. (K6) CO5: Explain the classification of PDEs of second order and solution of wave equation by using method of separation of variable. (K2, K3, K4) CO6: Explain and evaluate the solution of heat equation in one dimension in various cases and solution of Laplace equation. (K2, K4, K6)	
7	Course Description	This course is an introduce the basic concepts of partial differential equations and introduce students to how to solve linear Partial Differential with different methods. Learn to solve first-order partial differential equations and formation of PDEs. Explore the methods to solve Linear homogeneous and non-homogeneous PDEs with constant coefficients. Students will also master the technique of separation of variables to solve PDEs and able to derive heat and wave equations.	
8	Outline syllabus		CO Mapping
	Unit 1	**Linear PDEs of order one:**	
	A	Formation of partial differential equations (a) by elimination of arbitrary constants	CO1
	B	(b) by elimination of arbitrary function	CO1
	C	Lagrange's method to solve linear PDEs. .	CO1
	Unit 2	**Linear homogeneous PDE with constant coefficient:**	
	A	Rules for finding complementary function	CO2, CO3
	B	shortcut methods to find particular integral for standard form of functions	CO3
	C	few general methods for specific forms.	CO3
	Unit 3	**Linear non-homogeneous PDE with constant coefficient:**	

	A	Rules for finding complementary function,	CO4
	B	few shortcut methods to find particular integral for standard form of functions, and few general methods for specific forms	CO4
	C	equations reducible to PDEs with constant coefficients	CO4
	Unit 4	**Classification of PDEs, variable separable method and wave equation:**	
	A	Classification of PDEs of second order, Boundary value problems, the principle of superposition,	CO5
	B	method of separation of variables, its application to solve wave equation	CO5
	C	D'Alembert's solution of wave equation in various cases..	CO5
	Unit 5	**Heat equation and Laplace equation:**	
	A	Solution of heat equation in one dimension in various cases	CO6
	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:25%; MSE:25% ESE:50%	
	Text book/s*	1) Schaum's Outline series of Partial Differential equations.	
	Other References	1. Elements of Partial Differential Equations by Ian N. Sneddon, McGRA-HILL Book Company.	

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CMS332.1	3	3	2	2		1								
CMS332.2	2	2	2	2		1								
CMS332.3	3	3	3	3		1								
CMS332.4	2	2	2	3		1								
CMS332.5	2	3	3	3		1								
CMS332.6	3	2	3	3		1								
Average	**2.5**	**2.5**	**2.5**	**2.6**		**1.0**								

School: SSBSR		**Batch: 2024-28**	
Programme: B.Sc. (Hons./Hons. With Research) Mathematics		**Academic Year: 2026-27**	
Branch: Mathematics		**Semester: V**	
1	Course Code	**CMS331**	
2	Course Title	**Numerical Methods**	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
	Course Status	CC	
5	Course Objective	1. To provide the student with numerical methods of solving the non-linear equations, interpolation, differentiation, and integration. 2. To improve the student's skills in numerical methods by using the MATLAB.	
6	Course Outcomes	The student will be able to: CO1: Solve a linear system of equations using an appropriation method and develop the algorithm in MATLAB. (K1, K3, K5, K6) CO2: Solve the algebraic or transcendental equations using numerical methods and develop the algorithm in MATLAB. (K1, K3, K5, K6) CO3: Discuss the finite difference methods to analyse the functions (K2, K4) CO4: Explain the divided difference and evaluate the function. (K2, K4, K5) CO5: Describe the numerical differentiation and evaluate the differentiation. (K1, K2, K5) CO6: Calculate a definite integral using an appropriation method and develop the algorithm in MATLAB. (K1, K3, K5, K6)	
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	**Solution of system of linear equations:**	
	A	Direct methods: Cramer's rule, Matrix inverse method	CO1
	B	Gauss elimination and Gauss-Jordan method	CO1
	C	Iterative methods: Jacobi's method, Gauss-Seidal method	CO1
	Unit 2	**System of Transcendental equations:**	
	A	Initial approximation of the roots, Bisection method, Method of false position	CO2
	B	Secant method, iteration method,	CO2
	C	Newton-Raphson method and its convergence.	CO2
	Unit 3	**Finite differences and Interpolation**	
	A	Finite difference operators, their properties and their interrelations, finite difference tables.	CO3
	B	Newton's forward and Newton's backward interpolation formula	CO3
	C	Central difference formulae including Stirling's formula, Bessel's formula.	CO3
	Unit 4	**Divided differences**	
	A	Operators and difference table	CO4

	B	Newton's divided difference formula	CO4
	C	Lagrange's interpolation formula.	CO4
	Unit 5	**Numerical differentiation and integration**	
	A	Differentiation using Newton's forward and backward formula	CO5
	B	Newton-Cotes Quadrature formula - derivations & comparison of Trapezoidal rule	CO6
	C	Simpson's 1/3 and 3/8 rules..	CO6
	Mode of examination	Theory	
	Weightage Distribution	CA:25%; MSE:25% ESE:50%	
	Text book/s*	1) An Introduction to Numerical Analysis by EndreSuli, David F. Mayers, Cambridge University Press, 2003.	
	Other References	1) Numerical methods for Scientific and Engineering Computation by Jain, Iyengar, Jain, New Age International Publishers, 2004.	

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CMS331.1	3	3	3	3	2	1					2	1	1	
CMS331.2	3	3	3	3	2	1					2	1	1	
CMS331.3	3	3	3	3	2	1					2	1	1	
CMS331.4	3	3	3	3	2	1					2	1	1	
CMS331.5	3	3	3	3	2	1					2	1	1	
CMS331.6	3	3	3	3	2	1					2	1	1	
Average	**3.0**	**3.0**	**3.0**	**3.0**	**2.0**	**1.0**					**2.0**	**1.0**	**1.0**	

School: SSBSR		Batch: 2024-28	
Programme: B.Sc. (Hons./Hons. With Research) Mathematics		Academic Year: 2026-27	
Branch: Mathematics		Semester: V	
1	Course Code	MTP3551	
2	Course Title	Introduction to Partial Differential Equations Lab	
3	Credits	2	
4	Contact Hours (L-T-P)	0-0-4	
	Course Status	CC	
5	Course Objective	1. To familiarize the student in introducing and exploring MATLAB software. 2. To enable the student on how to approach for solving problems of Partial Differential Equations using MATLAB tools. 3. To understand the use of MATLAB in Laplace Transforms. 4. To prepare the students to use MATLAB in their project works. 5.To provide a foundation in use of this software for real time applications.	
6	Course Outcomes	The student will be able to write a code in Mathematica /MATLAB /Maple /Scilab/Maxima CO1: to find the solution of first order Partial Differential Equations. (K1, K2, K3) CO2: to find the solution of Linear homogeneous PDE with constant (K1, K2, K3) CO3: to solve the Linear non-homogeneous PDE with constant coefficient. (K2, K3) CO4: to explore the concept of Classification of PDEs of second order with help of MATLAB. (K3, K4, K5) CO5: to apply the concept of MATLAB for to discuss the solution of heat equation in one dimension. (K4, K5, K6) CO6: to discuss the Solution of Laplace equation in Cartesian coordinates (K4, K5, K6)	
7	Course Description	The course is an introduction to the MATLAB in Partial Differential Equations.The primary objective of the course is to develop basic mathematical modelling and to solve various equations using MATLAB.	
8	**Outline syllabus**		**CO Mapping**
	Unit 1		
	A, B, C	15.)Solution of first order Partial Differential Equations 16.) Lagrange's method to solve linear PDEs. .	CO 1
	Unit 2		
	A, B, C	17.)Linear homogeneous PDE with constant 18.)Particular integral for some specific cases.	CO 2
	Unit 3		
	A, B, C	19.)Linear non-homogeneous PDE with constant coefficient. 20.)finding complementary function.	CO 3
	Unit 4		
	A, B, C	21.)Classification of PDEs of second order, 22.)method of separation of variables 23.)D'Alembert's solution of wave equation	CO 4
	Unit 5		
	A, B, C	24.) Solution of heat equation in one dimension, 25.)Solution of Laplace equation in Cartesian coordinates	CO 5, CO 6

	Mode of examination	Practical + viva	
	Weightage Distribution	CA:30%; CE:30%; ESE:40%	
	Text book/s*	1. B.D. Hahn, Essential MATLAB for Scientists and Engineers, John Wiley & Sons, New York, NY, 1997.	
	Other References	1. Applied Numerical Methods with Matlab for engineering and Scientists by stevenchapra, Mcgraw Hill..	

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
MTP3551.1	3	3	3	3	2	1	2	3	2	2	3	2	2	
MTP3551.2	3	3	3	3	2	1	2	3	2	2	3	2	2	
MTP3551.3	3	3	3	3	2	1	2	3	2	2	3	2	2	
MTP3551.4	3	3	3	3	2	1	2	3	3	2	3	2	2	
MTP3551.5	3	3	3	3	2	1	2	3	2	2	3	2	2	
MTP3551.6	3	3	3	3	2	1	2	3	3	2	3	2	2	
Average	**3.0**	**3.0**	**3.0**	**3.0**	**2.0**	**1.0**	**2.0**	**3.0**	**2.3**	**2.0**	**3.0**	**2.0**	**2.0**	

School: SSBSR		Batch: 2024-28	
Programme: B.Sc. (Hons./Hons. With Research) Mathematics		Academic Year: 2026-27	
Branch: Mathematics		Semester: V	
1	Course Code	MTP3552	
2	Course Title	Mathematical Modelling Lab	
3	Credits	2	
4	Contact Hours (L-T-P)	0-0-4	
	Course Status	CC	
5	Course Objective	1. To familiarize the student in introducing and exploring MATLAB software. 2. To enable the student on how to approach for solving real life problems using different Mathematical perspectives.	
6	Course Outcomes	The student will be able to CO1: understand the basic concept of mathematical modelling in Matlab. CO2: to find the solution of the linear functions and their applications in Matlab. CO3: learn the Linear regression; modeling with exponential function in Matlab. CO4: understand to analyze the polynomial function and their applications in Matlab. CO5: to the discuss the different compartmental models in Matlab. CO6: identify and develop research models from the verbal description of the real system in Matlab	
7	Course Description	This course is an introduction to Matlab in mathematical modeling in based on the use of elementary functions to describe and explore real-world phenomena and data. The primary objective of this course is to develop basic mathematical modelling and to solve various mathematical models in Matlab.	
8	**Outline syllabus**		**CO Mapping**
	Unit 1		
	A, B, C	(1) Solution of mathematical models and simulation (2) Stochastic and deterministic models (3) Modelling for decision making	CO1
	Unit 2		
	A, B, C	(4) Linear functions, fitting linear models to data, Evaluating model error (5) Interpreting the correlation coefficient	CO2
	Unit 3		
	A, B, C	(6) Exponential growth functions with applications (7) Exponential decay functions with applications	CO3
	Unit 4		
	A, B, C	(8) Modeling with polynomial functions	CO4
	Unit 5		
	A	(9) Compartmental models and Exponential decay (10) Lake pollution models, disease compartmental models	CO5, CO6
	Mode of examination	Lab	
	Weightage Distribution	CA:30%; CE:30%; ESE:40%	
	Text book/s*	1.Sheldon Lee, La Crosse, WI, Megan Buzby, Juneau, AK, Mathematical Modeling and Simulation with MATLAB University of Alaska Southeast, 2011.	
	Other References	1.Sandip Banerjee, Mathematical Modeling: Models, Analysis and Applications, Chapman and Hall/CRC.	

		2.Barnes and G R Fulford , Mathematical Modelling with Case Studies: A Differential Equations Approach using Maple and MATLAB.	

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
MTP3552.1	3	3	3	3	2	2	1	3	2	1	2	2	2	
MTP3552.2	3	3	3	3	2	2	1	3	2	1	2	2	2	
MTP3552.3	3	3	3	3	2	2	1	3	2	1	2	2	2	
MTP3552.4	3	3	3	3	2	2	1	3	2	1	2	2	2	
MTP3552.5	3	3	3	3	2	2	1	3	2	1	2	2	2	
MTP3552.6	3	3	3	3	2	2	1	3	2	1	2	2	2	
Average	**3.0**	**3.0**	**3.0**	**3.0**	**2.0**	**2.0**	**1.0**	**3.0**	**2.0**	**1.0**	**2.0**	**2.0**	**2.0**	

School: SSBSR		**Batch: 2024-28**	
Programme: B.Sc. (Hons./Hons. With Research) Mathematics		**Academic Year: 2026-27**	
Branch: Mathematics		**Semester: V**	
1	Course Code	**MTR3551**	
2	Course Title	**Research Based Learning-III**	
3	Credits	0	
4	Contact Hours (L-T-P)	0-0-2	
	Course Status	Project	
5	Course Objective	The course develops students' understanding of the research process and fosters interest in mathematics while enhancing organizational skills and aligning activities with professional goals. It also encourages applying research findings to improve educational theory and practice.	
6	Course Outcomes	CO1: Explain the concept of research within the subject, as regards approaching a question, collecting and analyzing background material, and presenting research questions and conclusions. (K2, K4) CO2: Construct and develop a deeper interest in mathematics and a taste for research. (K5, K6) CO3:Select and recommend activities that support their professional goals. (K4) CO4: Develop effective project organizational skills. (K5) CO5: Analyse the data and its interpretation. (K4,K5) CO6: Use research findings to develop education theory and practice. (K3,K6)	
7	Course Description	This course equips students with research skills in mathematics, focusing on question formulation, analysis, and presentation of findings. It fosters interest in research while enhancing organizational skills and aligning activities with professional goals.	
8			
	Unit 1	**Introduction**	**CO1**
		Formulation of introductory paragraph explaining in short, topics relevant to research	
	Unit 2	**Case study**	**CO1,CO2**
		Detailed investigation of the data collected for a deeper and clearer understanding of the complexities	
	Unit 3	**Conceptual**	**CO3, CO4**
		Conceptual study of the problem based on objectives.	
	Unit 4	**Development**	**CO4, CO5**
		Development of model based on objectives.	
	Unit 5	**Finalisation**	**CO5, CO6**
		Data analysis with model and its interpretation	
	Mode of examination	Project	
	Weightage Distribution	CA: 25%; CE: 25%; ESE: 40%	
	Text book/s*	Research Methodology by C R Kothari; A Beginners Guide To Research Methodology by Ashreet Acharya and A. Anamika	
	Other References		

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
MTR3551.1		2	1	2	2	1		3			2	2	2	2
MTR3551.2		2	1	2	2	1		3			2	2	2	2
MTR3551.3		2	1	2	2	1		3			2	2	2	2
MTR3551.4		2	1	2	2	1		3			2	2	2	2
MTR3551.5		2	1	2	2	1		3			2	2	2	2
MTR3551.6		2	1	2	2	1		3			2	2	2	2
Average		**2.0**	**1.0**	**2.0**	**2.0**	**1.0**		**3.0**			**2.0**	**2.0**	**2.0**	**2.0**

School: SSBSR		**Batch: 2024-28**	
Programme: B.Sc. (Hons./Hons. With Research) Mathematics		**Academic Year: 2026-27**	
Branch: Mathematics		**Semester: VI**	
1	Course Code	**CMS433**	
2	Course Title	**Integral Equations & Calculus of Variations**	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
	Course Status	Minor	
5	Course Objective	1. The main objectives of this course are to introduce the methods and concepts for solving linear integral equations, to study Laplace and Fourier transforms with their applications to DE. 2. Integral equations and to provide an understanding the problems through calculus of variations. .	
6	Course Outcomes	The student will be able to CO1: understand the basic concept of integral equation Volteraa as well as Fredholm. CO2: understand the eigen values and eigen function of HFIE. CO3: to learn the solution of PDE by Laplace transform. CO4: understand to analyze the Fourier transform and their applications. CO5: to learn the extremal variational by Eulers equation. CO6: identify variation of a functional and its properties, extremum of functional, necessary condition for an extremum..	
7	Course Description	This course is determine the solutions to Volterra as well as Fredholm integral equations by method of resolvent kernel, method of successive approximations, method of integral transforms, understand with eigen values and eigen functions of homogeneous Fredholm integral equations, calculate the Laplace transform, Fourier transform and their inverse transforms of common functions and understand the formulation of variational problems, the variation of a functional and its properties, extremum of functional, necessary condition for an extremum. .	
8	**Outline syllabus**		**CO Mapping**
	Unit 1	**Linear Integral Equations**	
	A	Definition, examples and classification of integral equations, Relation between differential and integral equations.	CO1
	B	Solution of Volterra as well as Fredholm integral equations of second kinds by the method of successive substitutions and successive approximations.	CO1
	C	Iterated and resolvent kernels.	CO1
	Unit 2	**More on Fredholm Equations**	
	A	Solution of Fredholm integral equations with separable kernels.	CO2
	B	Eigen values and eigen functions of Homogeneous Fredholm integral equations.	CO2

	C	Solution of integral equations with symmetric kernels, Fundamental properties of Eigenvalues and Eigen functions for symmetric equations.	CO2
	Unit 3	**Integral Transforms**	
	A	Revisit to Laplace transform.	CO3
	B	Solution of integral equations and PDEs by Laplace transform method.	CO3
	C	Piecewise continuity and Dirichlet's conditions.	CO3
	Unit 4	**Fourier transform and Their Applications**	
	A	Fourier integrals, Fourier sine and cosine integrals.	CO4
	B	Fourier transform, Fourier sine transform, Fourier cosine transform and their inversion formulae.	CO4
	C	Fourier transform of elementary functions, Properties of Fourier transform, Solution of integral equations.	CO4
	Unit 5	**Calculus of Variations**	
	A	Functional and its variation and extremal, Variational principle, Euler's equation and its different cases.	CO5
	B	Invariance of Euler's equation under coordinates transformation, Functional involving several dependent variables.	CO5
	C	Functional depending on higher order derivatives, Functionals dependent on functions of several independent variables.	CO6
	Mode of examination	Theory	
	Weightage Distribution	CA:25%; MSE:25% ESE:50%	
	Text book/s*	1. M. Gelfand and S. V. Fomin: Calculus of Variations, Dover Books, 2000. (For Unit 5)	
	Other References	1. Pinkus Allan and Samy Zafrany: Fourier Series and Integral Transforms, Cambridge University Press, 1997. (For Unit 4).	

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CMS433.1	3	3	3	3	2	1					2			
CMS433.2	3	3	3	3	2	1					2			
CMS433.3	3	3	3	3	2	1					2			
CMS433.4	3	3	3	3	2	1					2			
CMS433.5	3	3	3	3	2	1					2			
CMS433.6	3	3	3	3	2	1					2			
Average	**3.0**	**3.0**	**3.0**	**3.0**	**2.0**	**1.0**					**2.0**			

School: SSBSR		Batch: 2024-28	
Programme: B.Sc. (Hons./Hons. With Research) Mathematics		**Academic Year: 2026-27**	
Branch: Mathematics		**Semester: VI**	
1	Course Code	**MSM312**	
2	Course Title	**Discrete Mathematics**	
3	Credits	**4**	
4	Contact Hours (L-T-P)	**3-1-0**	
	Course Status	**Minor**	
5	Course Objective	This course is aimed to provide an advance understanding to the sets and propositions, relations and functions, permutation and combination, graphs, groups and rings.	
6	Course Outcomes	CO1: Discuss the concept of sets, un-countably infinite sets, principle of inclusion and exclusion, multisets, propositions, conditional propositions and evaluate normal forms, Mathematical induction. (K2,K3, K4,K5) CO2: Describe the concept functions, composition of function, invertible functions, discrete properties of binary relations and check the closure of relations. (K3, K6) CO 3: Explain the concept of POSET and lattices, Warshall's algorithm, Equivalence relations and partitions and evaluate Chains, and Anti-chains. Generating Functions, Recurrence relations and discuss linear recurrence relations with constant coefficient, homogeneous solution, total solutions, solutions by method of Generating function. (K2, K4,K5) CO 4: Illustrate the concept permutations and combinations: rule of sum and product, write the algorithms for generation of permutations and combination. (K3, K5,K6) CO 5: Discuss the concept graph, sub-graph, Walks, Path and circuits, Connected graphs, Disconnected graphs and component, evaluate the fundamental circuits, distance, diameters, radius and pendant vertices, rooted and binary trees (K1,K2,K5,K6) CO6: Demonstrate the understanding of Algebraic systems, Group and evaluate Semi-groups, Monoid, Subgroups, Isomorphism and Automorphism. (K2, K5)	
7	Course Description	This course is given the deep knowledge of sets and propositions, relations and functions, permutation and combination, graphs, groups and rings.	
8	**Outline syllabus**		**CO Mapping**
	Unit 1	**Sets and Propositions**	
	A	Sets, Un-countably infinite sets, Principle of inclusion and exclusion, multisets, propositions,	CO1
	B	Conditional propositions. Logical connectivity, Propositional, calculus,	CO1, CO2
	C	Universal and existential quantifiers, Normal forms, methods of proofs, Mathematical induction.	CO2
	Unit 2	**Relations and Functions**	
	A	Functions, Composition of function, invertible functions, Discrete properties of binary relations, closure of relations	CO3
	B	Warshall's algorithm, Equivalence relations and partitions, Ordered Sets and Lattices: Introduction, Ordered set,	CO3
	C	Hasse diagram of partially ordered set, Consistent enumeration,	CO3

		Isomorphic ordered set, Well ordered set, Lattices, Properties of lattices, Bounded lattices, Distributive lattices, and Complemented lattices. Chains, and Anti-chains.	
	Unit 3	**Number Theory**	
	A	Counting: Basic counting principles, factorial notation, Binomial coefficients, Ordered and unordered partitions.	CO4
	B	Permutations and combinations: Rule of sum and Product, Permutations, Combination, Algorithms for Generation of Permutations and Combination,	CO4
	C	The Pigeonhole principle, Fundamental theorem of arithmetic, Congruence relation, Congruence Equations.	CO4
	Unit 4	**Recurrence Relations and Algebraic Structures**	
	A	Discrete Numeric Functions and Generating functions,	CO5
	B	Simple Recurrence relation with constant coefficients	CO5
	C	Linear recurrence relations without constant coefficients, Asymptotic behavior of functions.	CO5
	Unit 5	**Algebraic Structures**	
	A	Algebraic systems, Group, Semi-groups, Monoid, Subgroups.	CO6
	B	Cyclic group, Permutation groups, Homomorphism,	CO6
	C	Isomorphism and Automorphism of groups.	CO6
	Mode of examination	**Theory**	
	Weightage Distribution	**CA:25%; MSE:25% ESE:50%**	
	Text book/s*	1. Liu C.L. and Mohapatra, D.P., " Elements of Discrete Mathematics" , SiE edition, TMH, 2008	
	Other References	1. Kenneth H.R.,' Discrete Mathematics and its Applications", Mc-Graw hill.	

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
MSM312.1		3	2	2		1					1			
MSM312.2		3	2	2		1					1			
MSM312.3		2	2	2		1					1			
MSM312.4		3	2	2		1					1			
MSM312.5		2	2	2		1					1			
MSM312.6		2	2	2		1					1			
		2.5	**2.0**	**2.0**		**1.0**					**1.0**			

School: SSBSR		**Batch: 2024- 2028**	
Programme: B.Sc. (Hons./Hons. With Research) Mathematics		**Academic Year: 2026-27**	
Branch: Mathematics		**Semester: VI**	
1	Course Code	MTT3601	
2	Course Title	Metrics Space	
3	Credits	3	
4	Contact Hours (L-T-P)	3-0-0	
	Course Status	DSE	
5	Course Objective	Familiarise students with basic concepts of metric spaces. Give an idea of the Metric space of the real line; subsets of the real line and limit points of sets. Have an understanding of a basis and sub-basis of a Metric space. Discuss a continuous function between two metric spaces and a homeomorphism between them. Know connectedness and compactness and appreciate these concepts in the context of properties of a continuous function.	
6	Course Outcomes	CO1: Explain the concept of a metric and metric spaces and open balls and open sets. (K2, K4) CO2: Apply the concept of convergence of a sequence in metric spaces and Cauchy sequences. (K3) CO3: Explain and use open spheres and close spheres, neighbourhood of a point, open sets, interior points, Limit points, Closed sets and closure of a set, Boundary points, diameter of a set, Subspace of a metric space. (K2, K3, K4) CO4: Explain convergent and Cauchy sequences, Complete metric space and evaluate Dense subsets and separable spaces, Nowhere dense sets, Continuous functions. (K2, K4,K5) CO5: Describe the Compact spaces, Sequential compactness and Bolzano-Weierstrass property, Finite Intersection property. (K1, K2) CO6: Understand and evaluate disconnected and connected sets, connected subsets of R, continuous functions and connected sets. (K2, K6)	
7	Course Description	This course will cover the basic concepts of metric spaces. Give an idea of the Metric space of the real line; subsets of the real line and limit points of sets. Have an understanding of a basis and sub-basis of a Metric space. Discuss a continuous function between two metric spaces and a homeomorphism between them. Know connectedness and compactness and appreciate these concepts in the context of properties of a continuous function.	
8	Outline syllabus		CO Mapping
	Unit 1	**Basic Concepts**	
	A	Definition and examples of metric spaces, Bounded and unbounded metric spaces, Distance between sets, Diameter of a set.	CO1, CO2
	B	Open and closed balls, Interior points and interior of a set, Open set, Neighbourhood of a point, Limit point of a set, Closure of a set, Closed set.	CO1, CO2
	C	Boundary points and boundary of a set, Exterior points and exterior of a set, Subspace of a metric space	CO1, CO2
	Unit 2	**Completeness and Separability**	
	A	Sequences and subsequence in a metric space, Convergent	CO1, CO3

		and Cauchy sequences.	
	B	Complete metric spaces, Relation between completeness and closedness, Cantor Intersection Theorem.	CO1, CO3
	C	Completion Theorem, Dense sets, Separable spaces, Nowhere dense sets.	CO1, CO3
	Unit 3	**Compactness**	
	A	Cover of a metric space, Compact metric spaces, Compact sets and their criterion.	CO1,CO4
	B	Properties of compact sets, Relation between compactness, completeness and closedness.	CO1,CO4
	C	Finite Intersection property, Bolzano-Weierstrass property, Sequential compactness, Totally bounded spaces.	CO1,CO4
	Unit 4	**Continuity and Fixed Points**	
	A	Continuous functions between two metric spaces, Characterizations of Continuous functions.	CO1, CO2, CO4
	B	Continuous functions on compact spaces, Uniform continuous functions.	CO1, CO2, CO4
	C	Homeomorphism and Isometry, Equicontinuity.	CO1, CO2, CO4
	Unit 5	**Advanced Theorems in Metric Spaces**	
	A	Components of a metric space, Connectedness of the product of connected metric spaces.	CO6,CO5
	B	Categories and Baire Category Theorem.	CO6,CO5
	C	Ascoli-Arzela Theorem, Fixed points, and Banach contraction theorem.	CO6,CO5
	Mode of examination	Theory	
	Weightage Distribution	CA / MTE / ETE 25% / 25% / 50%	
	Text books	1. G.F. Simmons: Introduction to Topology and Modern Analysis, McGraw Hill, 1963.	
	Other references	1. E.T. Copson: Metric Spaces, Cambridge University Press, 1968. 2. P.K. Jain and Khalil Ahmad: Metric Spaces, Second Edition, Narosa Publishing House, New Delhi, 2003. 3. B. K. Tyagi: First Course in Metric Spaces, Cambridge University Press, 2010.	

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
MTT3601.1	3	3	2	2	2	3	2	2	1	1
MTT3601.2	2	3	3	3	3	2	1	2	2	2
MTT3601.3	2	3	2	1	2	2	2	1	2	2
MTT3601.4	2	2	2	3	2	2	1	2	2	2
MTT3601.5	3	2	2	3	2	2	2	2	2	1
MTT3601.6	3	3	2	2	3	3	2	2	2	2

School: SSBSR		**Batch: 2024-28**	
Programme: B.Sc. (Hons./Hons. With Research) Mathematics		**Academic Year: 2026-27**	
Branch: Mathematics		**Semester: VI**	
1	Course Code	**ARP306**	
2	Course Title	**Campus to Corporate**	
3	Credits	**2**	
4	Contact Hours (L-T-P)	**1-0-2**	
	Course Status	**AEC**	
5	Course Objective	To enhance holistic development of students and improve their employability skills. Provide a 360 degree exposure to learning elements of Business English readiness program, behavioural traits, achieve softer communication levels and a positive self-branding along with augmenting numerical and altitudinal abilities. To up skill and upgrade students' across varied industry needs to enhance employability skills. By the end of this semester, a will have entered the threshold of his/her 4th phase of employability enhancement and skill building activity exercise.	
6	Course Outcomes	After completion of this course, students will be able to: CO1: Develop a creative resumes, cover letters, interpret job descriptions and interpret KRA and KPI statements and art of conflict management. CO2: Build negotiation skills to get maximum benefits from deals in practical life scenarios. CO3: Develop skills of personal branding to create a brand image and self-branding CO4: Acquire higher level competency in use of logical and analytical reasoning such as direction sense, strong and weak arguments CO5: Develop higher level strategic thinking and diverse mathematical concepts through building analogies, odd one out CO6: Demonstrate higher level quantitative aptitude such as average, ratio & proportions, mixtures & allegation for making business decisions.	
7	Course Description	This penultimate stage introduces the student to the basics of Human Resources. Allows the student to understand and interpret KRA | KPI and understand Job descriptions. A student also understands how to manage conflicts, brand himself/herself, understand relations and empathise others with level-4 of quant, aptitude and logical reasoning	
8	Outline syllabus – ARP 306		
	Unit 1	**Ace the Interview**	**CO**

			MAPPING
	A	HR Sensitization (Role Clarity | KRA | KPI | Understanding JD) | Conflict Management	CO1
	B	Negotiation Skills | Personal Branding	CO3, CO4
	C	Uploading & Curating Resumes in Job Portals, getting Your Resumes Noticed | Writing Cover Letters | Relationship Management	CO1, CO3
	Unit 2	**Introduction to APTITUDE TRAINING- Reasoning- Logical/ Analytical**	
	A	Sitting Arrangement & Venn Diagrams | Puzzles | Distribution | Selection	CO4
	B	Direction Sense | Statement & Conclusion | Strong & Weak Arguments	CO4
	C	Analogies, Odd One out | Cause & Effect	CO5
	Unit 3	**Quantitative Aptitude**	
	A	Average , Ratio & Proportions, Mixtures & Allegation	CO6
	B	Geometry-Lines, Angles & Triangles	CO6
	C	Problem of Ages | Data Sufficiency - L2	CO6
	Unit 4	**Verbal Abilities-4**	
	A	Antonyms and Synonyms	CO1
	B	Idioms and Phrases	CO2
	Unit 5	**Problem Solving and Case Studies**	
	A	Real time Case Study Solving Exercises	CO4
	B	Intra student Mock Situation Handling Exercises	CO4
	Evaluation Weightage	(CA)Class Assignment/Free Speech Exercises / JAM – 60% | (ETE) Group Presentations/Mock Interviews(MIP's)/GD/ Reasoning, Quant & Aptitude– 40%	
	Text book/s*	Wiley's Quantitative Aptitude-P Anand | **Quantum CAT – Arihant Publications | Quicker Maths- M. Tyra |** Power of Positive Action (English, Paperback, Napoleon Hill) | Streets of Attitude (English, Paperback, Cary Fagan, Elizabeth Wilson) The 6 Pillars of self-esteem and awareness – Nathaniel Brandon | Goal Setting (English, Paperback, Wilson Dobson	

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
ARP306.1			2	2		3	1	3	1		2			
ARP306.2			3	2		3	1	3	1		2			
ARP306.3			2	2		3	1	3	1		2			
ARP306.4			2	2		3	1	3	1		2			
ARP306.5			2	2		3	1	3	1		2			
ARP306.6			2	2		3	1	3	1		2			
Average			**2.0**	**2.0**		**3.0**	**1.0**	**3.0**	**1.0**		**2.0**			

School: SSBSR		**Batch: 2024-28**	
Programme: B.Sc. (Hons./Hons. With Research) Mathematics		**Academic Year: 2026-27**	
Branch: Mathematics		**Semester: VI**	
1	Course Code	**AI3409**	
2	Course Title	Advanced Machine Learning Techniques	
3	Credits	4	
4	Contact Hours (L-T-P)	0-0-8	
	Course Status	Minor	
5	**Course Objective**	To provide students with a strong understanding of advanced machine learning and its applications in data science through hands-on practice. The course covers reinforcement learning, neural networks, and deep learning models while incorporating essential mathematical concepts such as probability, linear algebra, and optimization**.** Students will explore techniques like feature engineering, model evaluation, and hyperparameter tuning to enhance machine learning model performance and apply them to real-world data science challenges**.**	
6	Course Outcomes	**CO1:** Understand and apply reinforcement learning techniques for data driven decision-making problems. **CO2:** Explain the structure of neural networks and train simple models using backpropagation **CO3:** Develop deep learning models using Convolutional Neural Networks (CNNs) and Recurrent Neural Networks (RNNs). **CO4:** Perform feature engineering techniques to enhance model performance in structured/tabular data analysis **CO5:** Evaluate machine learning models using appropriate metrics and techniques. **CO6**: Interpret machine learning models and analyze ethical concerns related to AI applications.	
7	Course Description	This course explores reinforcement learning, neural networks, deep learning, and large language models (LLMs). It covers AI architectures, optimization techniques, real-world applications, ethical concerns, and future AI trends.	
8	Outline syllabus		CO Mapping
	Unit 1	**Introduction to Reinforcement Learning**	
	A	Basics of reinforcement learning (RL) – Agents, actions, rewards, environments.	CO1
	B	Q-learning and policy-based RL methods – Concept, advantages, and applications.	CO2
	C	Implement Q-learning in a simple environment (e.g., GridWorld), and train an agent using Deep Q-Networks (DQN) in OpenAI Gym.	CO2
	Unit 2	**Neural Networks & Training**	
	A	Structure of neural networks – Neurons, layers, weights, and activation functions.	CO3

	B	Backpropagation and optimization techniques (Gradient Descent, Adam).			CO3
	C	Implement a simple feedforward neural network in PyTorch, experiment with activation functions, and train/test on small datasets.			CO3
	Unit 3	**Deep Learning Applications**			
	A	Introduction to deep learning architectures – CNNs, RNNs, LSTMs, and their key differences from traditional ML.			CO4
	B	Applications of deep learning in real-world problems like image recognition, speech processing, and healthcare.			CO4
	C	Implement CNNs for image classification (e.g., MNIST, CIFAR-10) and train RNNs/LSTMs for text generation tasks.			CO4
	Unit 4	**Feature Engineering & Model Evaluation**			
	A	Basics of Feature Engineering – Importance of feature selection, feature scaling, and feature transformation (PCA).			CO5
	B	Model Evaluation Techniques – Accuracy, Precision, Recall, F1-score, and ROC curves.			CO5
	C	Implement feature engineering techniques and compare model performance using different evaluation metrics on a real-world dataset			CO5
	Unit 5	**AI Ethics & Future Trends**			
	A	Challenges in AI ethics – Bias, fairness, and transparency in machine learning models.			CO5
	B	AI interpretability – SHAP, LIME, and explainability techniques.			CO5
	C	Explore model interpretability using SHAP/LIME and evaluate AI safety concerns in real-world applications.			CO6
	Mode of examination	Practical			
	Weightage Distribution	CA	MTE	ETE	
		25%	25%	50%	
	Text book/s*				
	Other References				

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
AI3409.1	2	1	2	2	1	3	1	3	1	1	2			
AI3409.2	2	1	2	2	1	3	1	3	1	2	2			
AI3409.3	2	1	2	2	1	3	1	3	1	1	2			
AI3409.4	2	1	2	2	1	3	1	3	1	2	2			
AI3409.5	2	1	2	2	1	3	1	3	1	1	2			
AI3409.6	2	1	2	2	1	3	1	3	1	2	2			
Average	**2**	**1**	**2.0**	**2.0**	**1**	**3.0**	**1.0**	**3.0**	**1.0**	**1.5**	**2.0**			

School: SSBSR		**Batch: 2024-28**	
Programme: B.Sc. (Hons./Hons. With Research) Mathematics		**Academic Year: 2026-27**	
Branch: Mathematics		**Semester: VI**	
1	Course Code	**INC001**	
2	Course Title	**Industry Connect**	
3	Credits	2	
4	Contact Hours (L-T-P)	0-0-4	
	Course Status	Project	
5	Course Objective	This course will expose students to applying theories learned in the classroom and provides current technological developments relevant to the subject area of training. Students will be able to identify their career preferences and professional goals.	
6	Course Outcomes	Students will be able to: CO1: Get familiar with industry principles and practices. CO2: Identify and analyze an appropriate problem. CO3: Develop teamwork and apply prior acquired knowledge in problem-solving. CO4: Demonstrate effective verbal and written communication skills. CO5: Practice scientists' responsibilities, self-understanding, self-discipline, and ethical standards. CO6: Identify the career preferences and professional goals.	
7	Course Description	The Internship aims to offer students the opportunity to apply their prior acquired knowledge in problem-solving. Students will acquire skills important for time management, discipline, self-learning, effective communication, and so on.	
8			
	Unit 1		
	A, B, C	Define objectives and conditions for the internship, ensuring students that it is related to the study path carried out at the University	CO1
	Unit 2		
	A, B, C	Problem Definition and identification, Team/Group formation, and Project Assignment. Finalizing the problem statement, and resource requirement, if any.	CO2,CO6,
	Unit 3		
	A, B, C	The internship work plan is drawn up by developing teamwork and applying prior acquired knowledge in problem-solving.	CO3,CO6,

	Unit 4		
	A, B, C	Demonstrate and execute Project with the team. Submission of the evaluation form and final report completed by the intern.	CO4,CO6
	Unit 5		
	A, B, C	Final evaluation form completed by the supervisor at the Host Organization and final presentation before the departmental committee.	CO5,CO6
	Mode of examination		
	Weightage Distribution		
	Text book/s*		
	Other References		

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PSO 1**	**PSO 2**	**PSO 3**
INC001.1		2	1	2	2	1	2	3	2	2	2	2	2	2
INC001.2		2	1	2	2	1	2	3	2	2	2	2	2	2
INC001.3		2	1	2	2	1	2	3	2	2	2	2	2	2
INC001.4		2	1	2	2	1	2	3	2	2	2	2	2	2
INC001.5		2	1	2	2	1	2	3	2	2	2	2	2	2
INC001.6		2	1	2	2	1	2	3	2	2	2	2	2	2
Average		**2.0**	**1.0**	**2.0**	**2.0**	**1.0**	**2.0**	**3.0**	**2.0**	**2.0**	**2.0**	**2.0**	**2.0**	**2.0**

School: SSBSR		**Batch: 2024-28**	
Programme: B.Sc. (Hons./Hons. With Research) Mathematics		**Academic Year: 2026-27**	
Branch: Data Science & Analytics		**Semester: VI**	
1	Course Code	**MTR3652**	
2	Course Title	**Research Based Learning-IV**	
3	Credits	1	
4	Contact Hours (L-T-P)	0-0-2	
	Course Status	Project	
5	Course Objective	1. Deep knowledge of a specific area of specialization. 2. Analyse research report writing and summarize research findings and submission for publication	
6	Course Outcomes	CO1: Explain the implementation of the model in the research work (K3, K4) CO2: compute validation of the model with assumption and its results. (K5, K6) CO3: evaluate the outcomes of the results. (K4, K6) CO4: Find the results and future scope and suggestions. (K5) CO5: Analyse research report writing and summarize research findings. (K4, K5) CO6: Comprehensive research report writing and submission for publication. (K3,K6)	
7	Course Description	Students will learn to analyze research findings, write comprehensive research reports, and prepare submissions for publication, with an emphasis on evaluating outcomes, identifying future scope, and offering suggestions for further research.	
8			
	Unit 1	**Overall Project Implementation**	**CO1, CO2**
		Implementation of the model in the research work	
	Unit 2	**Validity of Result, Assumption and System Model**	**CO2,CO3**
		Validation of model with assumption and its results	
	Unit 3	**Results and Expected Outcomes**	**CO3, CO4**
		Outcomes of the results	
	Unit 4	**Conclusion and Future Suggestions**	**CO4, CO5**
		Conclusion of the results and future scope and recommendations	
	Unit 5	**Report Writing and Submission**	**CO5, CO6**
		Comprehensive research report writing and submission to the journal/book chapter/conference paper for publication	
	Mode of examination	Project	
	Weightage Distribution	CA: 25%; CE: 25%; ESE: 50%	
	Text book/s*	Research Methodology by C R Kothari; A Beginners Guide To Research Methodology by Ashreet Acharya and Abhipsa Anamika	
	Other References		

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
MTR352.1				2	3	3	3	3	3	3	3	3	1	1
MTR352.2				2	3	3	3	3	3	3	3	3	1	1
MTR352.3				2	3	3	3	3	3	3	3	3	1	1
MTR352.4				2	3	3	3	3	3	3	3	3	1	1
MTR352.5				2	3	3	3	3	3	3	3	3	1	1
MTR352.6				2	3	3	3	3	3	3	3	3	1	1
Average				2	3	3	3	3	3	3	3	3	1	1

School: SSBSR		**Batch: 2024-28**	
Programme: B.Sc. (Hons./Hons. With Research) Mathematics		**Academic Year: 2027-28**	
Branch: Mathematics		**Semester: VII**	
1	Course Code	**CMS403**	
2	Course Title	**Number Theory**	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
	Course Status	CC	
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 congruencies 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, quadratic 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, congruence, quadratic residues, some standard arithmetic functions.	
8	**Outline syllabus**		**CO Mapping**
	Unit 1	**BASICS**	
	A	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, 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.	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	Gauss lemma.	CO4
	B	Legendre symbol, Jacobi symbol	CO4
	C	Quadratic reciprocity law.	CO4
	Unit 5	**SOME STANDARD ARITHMETIC FUNCTIONS**	
	A	The greatest integer function, Euler's totient function.	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:25%; MSE:25% ESE: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	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CMS403.1	2	3	1	1		1					1	2	2	
CMS403.2	2	2	3	2		1					1	2	2	
CMS403.3	2	2	1	1		1					1	2	2	
CMS403.4	2	2	3	1		1					1	1	2	
CMS403.5	3	2	3	1		1					1	3	2	
CMS403.6	3	1	1	1		3					1	2	2	
Average	**2.3**	**2**	**1.6**	**1.8**		**1.3**					**1.0**	**2**	**2.0**	

School: SSBSR		**Batch: 2024-28**	
Programme: M.Sc.		**Academic Year: 2027-28**	
Branch: Mathematics		**Semester: VII**	
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	CC	
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	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	Scripts and functions	CO2,CO5
	B	concept of local and global variable	CO2,CO5
	C	Few examples of in-built functions, editing, saving m-files.	CO2,CO5
	Unit 4	**Two dimensional Graphics**	
	A	Basic Plots, Change in axes and annotation in a figure	CO4

	B	multiple plots in a figure			CO4
	C	saving and printing figures			CO4
	Unit 5	**Applications of MATLAB**			
	A	Solving a linear system of equations,			CO5, CO6
	B	Curve fitting with polynomials using inbuilt function such as polyfit, solving equations in one variable,			CO5, CO6
	C	Solving ordinary differential equations using inbuilt functions			CO5, CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		25%	25%	50%	
	Text book	An introduction to MATLAB : Amos Gilat			
	Other References	2. Applied Numerical Methods with Matlab for engineering and Scientists by stevenchapra, Mcgraw Hill. 3. 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: SSBSR		**Batch: 2024-28**
Programme: M. Sc.		**Academic Year: 2027-28**
Branch: Statistics		**Semester: VII**
1	Course Code.	STT4704
2	Course Title	Probability & Statistical Methods
3	Credits	4
4	Contact Hours (L-T-P)	4-0-0
	Course status	CC
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: SSBSR		**Batch: 2024-28**	
Programme: B.Sc. (Hons./Hons. With Research) Mathematics		**Academic Year: 2027-28**	
Branch: Mathematics		**Semester: VII**	
1	Course Code	**MMT209**	
2	Course Title	**Econometrics**	
3	Credits	3	
4	Contact Hours (L-T-P)	3-0-0	
	Course Status	DSE	
5	Course Objective	The objective of this course is to introduce regression analysis to students so that understand its applications in different fields of economics.	
6	Course Outcomes	CO1: Able to have concise knowledge of basic regression analysis of economic data and interpret and critically evaluate outcomes of empirical analysis. (K1, K2, K3). CO2: Analyze the theoretical background for standard methods used in empirical analyses, like properties of least squares estimators and statistical testing of hypotheses. (K2, K3, K4). CO3: Able to apply for modern computer programs in regression analyses of empirical data, including statistical testing to investigate whether the classical assumptions in regression analysis are satisfied. (K2, K3, K4). CO4: Design and development of a real-life model based on econometric methods. (K4, K5, K6) CO5: Develop and apply advance methods for the implementation of econometric techniques also various functions for economic analysis and future forecasting. (K5, K6). CO6: Enable students to make use of econometric models in their academic work. (K4,K5)	
7	Course Description	The purpose of this course is to give students a solid foundation in econometric techniques, various functions for economic analysis, and future forecasting. Many of the methods introduced in this course are also useful in business, finance, and many other disciplines.	
8			
	Unit 1		
	A	Introduction to econometrics. A review of least squares and maximum likelihood estimation methods of parameters in the classical linear regression model and their properties.	CO1
	B	Generalized least squares estimation and prediction, construction of confidence regions.	CO1
	C	Tests of hypotheses, use of dummy variables, and seasonal adjustment.	CO1
	Unit 2		
	A	Regression analysis under linear restrictions, restricted least squares estimation method and its properties.	CO2
	B	Problem of Multicollinearity, its implications, and tools for handling the problem.	CO2
	C	Ridge regression. Heteroscedasticity, consequences, and tests for it.	CO2
	Unit 3		

	A	Estimation procedures under heteroscedastic disturbances, Bartlett's test, Breusch Pagan test, and Goldfelf Quandt test.	CO3
	B	Autocorrelation, sources, and consequences.	CO3
	C	Autoregressive process tests for autocorrelation.	CO4
	Unit 4		
	A	Durbin Watson test. Asymptotic theory and regressors.	CO5
	B	Instrumental variable estimation, errors in variables.	CO5
	C	Simultaneous equations model, the problem of identification, a necessary and sufficient condition for the identifiability of parameters in a structural equation.	CO5
	Unit 5		
	A	Ordinary least squares, indirect least squares.	CO6
	B	Two-stage least square.	CO6
	C	Limited information maximum likelihood method.	CO6
	Mode of examination	Theory	
	Weightage Distribution	CA:25%; MSE:25% ESE:50%	
	Text book/s*	1. Maddala, G.S. &Lahiri, K. (2010). Introduction to Econometrics, 4th Edition.Wiley.	
	Other References	1. Greene, W.H. (2012).Econometric Analysis, 7th Edition.Pearson.	

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
MMT209.1		2	1	2		1		3			3			1
MMT209.2		2	1	2		1		3			3			1
MMT209.3		2	1	2		1		3			3			1
MMT209.4		2	1	2		1		3			3			1
MMT209.5		2	1	2		1		3			3			1
MMT209.6		2	1	2		1		3			3			1
Average		**2.0**	**1.0**	**2.0**		**1.0**		**3.0**			**3.0**			**1.0**

School: SSBSR		**Batch: 2024-28**	
Programme: B.Sc. (Hons./Hons. With Research) Mathematics		**Academic Year: 2027-28**	
Branch: Mathematics		**Semester: VII**	
1	Course Code	MMT-151	
2	Course Title	Mathematics Lab I	
3	Credits	2	
4	Contact Hours (L-T-P)	0-0-4	
	Course Status	CC	
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 Programming 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, Programming 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	**Practical based** MATLAB as a calculator.	**CO1**
		Creating an Array in MATLAB	CO1
	Unit 2	**Practical related to --** Mathematical Operations with Arrays	**CO3**

	Unit 3	**Practical related to---** How to make scripts files in MATLAB and do some examples.	**CO4**
	Unit 4	**Practical related to---** Make some function files in MATLAB. Basic two-dimensional and three-dimensional	**CO5,CO6**

		plotting, change in axes and annotation in a figure.			
	Unit 5	**Practical related to---** If-End statement, If-Else-End statement, nested If-Else-End statement Solving a system of linear equations, curve fitting with polynomials using inbuilt functions such as polyfit.			**CO2,CO6**
	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. 2. Getting started with Matlab: RudraPratap			

COURSE OUTCOMES – PROGRAMMEME OUTCOMES MAPPING TABLE

PO / CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
MMT151.1	**3**	**3**	**2**	**2**	**2**	**3**	**2**	**2**	**3**
MMT151.2	**2**	**3**	**3**	**3**	**3**	**2**	**3**	**3**	**2**
MMT151.3	**2**	**3**	**2**	**2**	**3**	**3**	**3**	**3**	**3**
MMT151.4	**2**	**3**	**2**	**3**	**2**	**2**	**2**	**3**	**2**
MMT151.5	**3**	**3**	**2**	**3**	**2**	**2**	**3**	**2**	**3**
MMT151.6	**2**	**2**	**3**	**3**	**2**	**2**	**2**	**2**	**3**

School: SSBSR		**Batch: 2024-28**	
Programme: B.Sc. (Hons./Hons. With Research) Mathematics		**Academic Year: 2027-28**	
Branch: Mathematics		**Semester: VII**	
1	Course Code	MMT 152	
2	Course Title	Mathematics Lab II	
3	Credits	2	
4	Contact Hours (L-T-P)	0-0-4	
	Course Status	CC	
5	Course Objective	To familiarize the student in introducing and exploring MS excel. To enable the student on how to approach for solving statistical problems using excel tools. To prepare the students to use excel in their project works. To provide a foundation in use of this MS office for real time applications.	
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	Enable students for using the computer Programme MS Excel, apply basic statistical techniques and methods for grouping, tabular and graphical display, analysis and interpretation of Statistical data.	
8	Outline syllabus		CO Mapping
	Unit 1	**Lab. Experiment 1:**	
		Exploring Data in Excel	CO1, CO2
	Unit 2	**Lab. Experiment 2:**	
		Create Charts	CO1, CO3

	Unit 3	**Lab. Experiment 3:**			
		Calculate Descriptive Statistics			CO1, CO4
	Unit 4	**Lab. Experiment 4:**			
		Calculate Correlation, Perform Regression,			**CO1,CO5**
	Unit 5	**Lab. Experiment 5:**			
		Survey on gender ethics using statistical tools.			**CO1, CO6**
	Mode of examination	**Practical**			
	Weightage Distribution	CA	CE	ETE	
		30%	30%	40%	
	Text book/s*				
	Other References				

COURSE OUTCOMES – PROGRAMMEME OUTCOMES MAPPING TABLE

PO / CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
MMT152.1	3	3	2	2	2	3	2	2	1
MMT152.2	2	3	3	3	3	2	1	2	1
MMT152.3	2	3	2	2	3	2	3	2	2
MMT152.4	2	3	2	3	2	2	2	2	3
MMT152.5	3	3	2	3	2	2	2	2	2
MMT152.6	3	2	2	2	3	2	2	2	3

School: SSBSR		Batch: 2024-28	
Programme: B.Sc. (Hons./Hons. With Research) Mathematics		Academic Year: 2027-28	
Branch: Mathematics		Semester: VII	
1	Course Code	Econometrics Lab	
2	Course Title	MDA156	
3	Credits	1	
4	Contact Hours (L-T-P)	0-0-2	
	Course Status	CC	
5	Course Objective	1. To enable the student in understanding and apply mathematical and statistical techniques to economic data in R/Excel 2. To enable students to identify the causal relationship and quantify the magnitude of these relationships. 3. To make Students learn how to specify appropriate econometric models to capture the relationships between economic variables 4. To enable Students how to collect, clean, and preprocess data, conduct exploratory data analysis, and apply econometric techniques to estimate and interpret the results. 5. To familiarize the students to assess the statistical significance of relationships and variables using Hypothesis testing.	
6	Course Outcomes	The student will be able to do exploratory data analysis of a time series data set. CO1: to find the estimates of the parameters using least square estimates and maximum likelihood estimates. (K1, K2, K3) CO2: to find the confidence interval and test for significance of the estimates of the parameters of classical linear regression. (K1, K2, K3) CO3: to solve the Linear non-homogeneous PDE with constant coefficient. (K2, K3) CO4: to employ Regression analysis under linear restriction and employ tests for Multicollinearity. (K3, K4, K5) CO5: to check whether data is having Heteroscedasticity by applying various methods. (K4, K5, K6) CO6: to determine whether there is autocorrelation in the data by using various tests. (K4, K5, K6)	
7	Course Description	The course is an introduction to R/Excel in Econometrics. The primary objective of the course is to develop basic knowledge of employing statistical techniques to economic data	
8	**Outline syllabus**		**CO Mapping**
	Unit 1	**Lab. Experiment 1**	
	A, B, C	Problem-based on estimation of parameters of classical linear regression by maximum likelihood estimation(MLEs), Least square estimation(LSE), Generalized least square estimation	CO1, CO2
	Unit 2	**Lab. Experiment 2**	
	A, B, C	Problem-based on Confidence interval of parameters, Test for the significance of estimates of the parameters. Use of dummy variable and seasonal adjustment.	CO2, CO3
	Unit 3	**Lab. Experiment 3**	
	A, B, C	Problem-based on Regression analysis under linear restriction Restricted least square estimation. Multicollinearity: test and tools to handle this problem	CO3, CO4
	Unit 4	**Lab. Experiment 4**	

	A, B, C	Problem-based on Heteroscedastic disturbances tests; Bartlett's test, Breusch pagan Test, Goldfelf Quandt test. .	CO5, CO6
	Unit 5	**Lab. Experiment 5**	
	A, B, C	Problem-based Autocorrelation sources; Autoregressive tests for autocorrelation. Durbin Watson test, Ordinary least square, indirect least square.	CO5, CO6
	Mode of examination	Practical + Viva	
	Weightage Distribution	CA:30%; CE:30%; ESE:40%	
	Text book/s*	1. B.D. Hahn, Essential MATLAB for Scientists and Engineers, John Wiley & Sons, New York, NY, 1997.	
	Other References	1. Applied Numerical Methods with Matlab for engineering and Scientists by stevenchapra, Mcgraw Hill..	

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
MDA156.1	1	2	2	2		1	1	3	1			1	2	
MDA156.2	1	2	3	2		1	1	3	1			1	2	
MDA156.3	1	2	2	2		1	1	3	1			1	2	
MDA156.4	1	2	2	2		1	1	3	1			1	2	
MDA156.5	1	2	2	2		1	1	3	1			1	2	
MDA156.6	1	2	2	2		1	1	3	1			1	2	
Average	**1.0**	**2.0**	**2.0**	**2.0**		**1.0**	**1.0**	**3.0**	**1.0**			**1.0**	**2.0**	

School: SSBSR		Batch: 2024-28
Programme: M. Sc.		Academic Year: 2027-28
Branch: Mathematics		Semester: VII
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	This course is an introduction to differential geometry and tensor analysis. The

	Description	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	1. Schaum's Outline Series of Differential Geometry	

COURSE OUTCOMES – PROGRAMMEME 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: SSBSR		**Batch: 2024-28**	
Programme: M.Sc.		**Academic Year: 2027-28**	
Branch: Mathematics		**Semester: VII**	
1	Course Code	MTR4755	
2	Course Title	Research Project- I	
3	Credits	3	
4	Contact Hours (L-T-P)	0-0-6	
	Course Status	Project	
5	Course Objective	• Develop foundational research skills in identifying, formulating, and planning a mathematical research problem. • Strengthen initial academic writing and literature review skills.	
6	Course Outcomes	CO1: Identify a relevant research problem in mathematics and formulate clear research objectives. (K2, K4) CO2: Conduct a preliminary literature review and establish the basic theoretical framework. (K4, K5) CO3: Develop a basic proposal and timeline for the full dissertation. (K5) 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 introduces students to the research process through identification of a research topic, preliminary literature review, and proposal writing. It lays the foundation for advanced research in the subsequent semester.	
8	Outline syllabus		CO Achievement
	Unit 1	**Introduction to Research and Problem Identification** • Understanding research in mathematics • Identifying potential problems • Formulating objectives and scope	**CO1**
	Unit 2	**Literature Review and Theoretical Orientation** Techniques for literature search • Review and synthesis of previous work • Conceptual framework formation	**CO1, CO2**
	Unit 3	**Proposal Development** Structuring a research proposal	**CO2, CO3**

		• Methodology outline • Planning and timeline	
	Unit 4	**Data Collection and Analysis** Execute data collection strategies as per the research design, where applicable. Employ advanced and appropriate mathematical techniques for thorough data analysis Interpret and contextualize the analytical results with respect to the research questions and the established theoretical framework.	**CO3, CO4**
	Unit 5	**Dissertation Writing and Defense** □ Structuring and writing the Research paper □ 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: 30% / CE: 30% / ETE: 40%	
	Text book/s*	-	
	Other References		

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
MTR4755.1	3	3	2	2	2	3	2	3	3
MTR4755.2	2	3	3	2	3	2	3	3	2
MTR4755.3	2	3	2	2	3	3	3	3	3
MTR4755.4	2	3	2	2	2	3	2	3	2
MTR4755.5	2	2	2	3	3	3	3	3	3
MTR4555.6	2	2	2	3	3	3	3	3	3

School: SSBSR		**Batch: 2024-28**	
Programme: B.Sc. (Hons./Hons. With Research) Mathematics		**Academic Year: 2027-28**	
Branch: Mathematics		**Semester: VIII**	
1	Course Code	**MDA110**	
2	Course Title	**Time Series, Forecasting and Index Number**	
3	Credits	3	
4	Contact Hours (L-T-P)	3-0-0	
	Course Status	DSE	
5	Course Objective	The objective of the course is to explain basic concepts of regression, time series, forecasting, and index numbers.	
6	Course Outcomes	CO1: Explain and illustrate the nature and uses of forecasts, some examples of time series, the forecasting process, resources for forecasting, statistics background for forecasting: graphical displays, numerical description of time series data (K2, K3) CO2: Describe how to evaluate least squares estimation in linear regression models, statistical inference in linear regression, prediction of new observations, model adequacy checking, model adequacy checking, generalized and weighted least squares, and regression models for general time series data. (K6) CO3: Explain and illustrate first-order exponential smoothing, modeling time series data, second-order exponential smoothing, and higher-order exponential smoothing. (K3, K6) CO4: Use forecasting: constant process, linear trend process, and evaluate the estimation of σ_e^2, adaptive updating of the discount factor, and model assessment. (K3, K6) CO5: Describe autoregressive integrated moving average (ARIMA) models. (K2) CO6: Explain and illustrate index numbers with the application. (K6)	
7	Course Description	This course will cover the fundamental concepts of Regression, time series, forecasting, and Index numbers.	
8	**Outline syllabus**		**CO Mapping**
	Unit 1		
	A	Introduction to Forecasting: The Nature and Uses of Forecasts, Some Examples of Time Series, The Forecasting Process, Resources for Forecasting,	CO1
	B	Statistics Background for Forecasting: Graphical Displays, Numerical Description of Time Series Data, Use of Data Transformations and Adjustments,	CO1
	C	General Approach to Time Series Modeling and Forecasting, Evaluating and Monitoring Forecasting Model Performance	CO1
	Unit 2		
	A	Regression Analysis and Forecasting: Least Squares Estimation in Linear Regression Models	CO2
	B	Model Adequacy Checking, Generalized and Weighted Least Squares, Regression Models for General Time Series Data.	CO2
	C	Statistical Inference in Linear Regression, Prediction of New Observations	CO2
	Unit 3		
	A	Introduction of Time series, Utility of Time series, Components of time series, Models of time series,	CO3

	B	Methods of measuring linear trends,	CO4
	C	Methods of measuring seasonal variation, Method of measuring cyclic variation	CO4
	Unit 4		
	A	Autoregressive Integrated Moving Average (ARIMA) Models: Linear Models for Stationary Time Series, Stationary Time Series, Finite Order Moving Average (MA) Processes.	CO5
	B	The First-Order Moving Average Process, MA(l), The Second-Order Moving Average Process, MA(2), Finite Order Autoregressive Processes, First -Order Autoregressive Process, AR(l), Second-Order Autoregressive Process, AR(2),	CO5
	C	General Autoregressive Process, AR(p), Partial Autocorrelation Function, PACF, Mixed Autoregressive-Moving Average CARMA) Processes, Time Series Model Building, Model Identification, Parameter Estimation, Examples of Building ARIMA Models, Forecasting ARIMA Processes.	CO5
	Unit 5		
	A	Index Numbers: Definition, construction of index numbers, and problems thereof for weighted and unweighted index numbers including	CO6
	B	Laspeyre's, Paasche's, Edgeworth-Marshall, and Fisher's. Chain index numbers,	CO6
	C	Conversion of fixed-based to chain-based index numbers and vice-versa. Consumer price index numbers.	CO6
	Mode of examination	Theory	
	Weightage Distribution	CA:25%; MSE:25% ESE:50%	
	Text book/s*	1. Daniel, Wayne W., "Biostatistics": Basic concept and Methodology for Health Science.	
	Other References	1. Goon, A.M., Gupta, A.K. & Das Gupta. Fundamental of Statistics.	

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
MDA110.1	3	3	2	2		1					2			2
MDA110.2	2	3	3	2		1					3			3
MDA110.3	2	2	2	3		1					2			2
MDA110.4	2	3	2	2		1					2			2
MDA110.5	3	3	2	2		1					2			2
MDA110.6	3	3	2	3		1					2			2
Average	**2.3**	**2.6**	**2.0**	**2.1**		**1.0**					**2.0**			**2.0**

School: SSBSR		**Batch :2024-28**	
Programme: B.Sc. (Hons./Hons. With Research) Mathematics		**Academic Year: 2027-28**	
Branch: Mathematics		**Semester: VIII**	
1	Course Code	MMT 203	
2	Course Title	LINEAR PROGRAMMEMING	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
	Course Status	Minor	
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	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	Basis of Queuing theory, elements of queuing theory.	CO3
	B	Kendall's Notation, Operating characteristics of a queuing system, Classification of 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, critical Path calculation.	CO6
	B	Float calculation and its importance.	CO6
	C	Cost reduction by Crashing of activity.	CO6
	Mode of examination	Theory	
	Weightage Distribution	CA:25%; MSE:25% ESE: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 Programmeming, 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 – PROGRAMMEME OUTCOMES MAPPING TABLE

PO / CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
MMT203.1	3	3	3	3	3	3	3	2	1
MMT203.2	3	2	3	3	2	3	2	1	2
MMT203.3	2	2	2	2	2	1	2	2	1
MMT203.4	2	2	1	3	2	2	3	1	1
MMT203.5	3	1	2	3	2	3	2	2	2
MMT203.6	3	2	1	3	2	2	2	1	1

School: SSBSR		Batch: 2024-28	
Programme: M.Sc.		Academic Year: 2027-28	
Branch: Mathematics		Semester: VIII	
1	Course Code	MMT107	
2	Course Title	TOPOLOGY	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
	Course Status	Minor	
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	CO2

		problems			
	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

School: SSBSR		**Batch: 2024-28**	
Programme: B.Sc. (Hons./Hons. With Research) Mathematics		**Academic Year: 2027-28**	
Branch: Mathematics		**Semester: VIII**	
1	Course Code	**CMS401**	
2	Course Title	**Numerical Solution of Differential Equations**	
3	Credits	**3**	
4	Contact Hours (L-T-P)	**3-0-0**	
	Course Status	**DSE**	
5	Course Objective	1. To develop systematic understanding of key aspects of finite difference methods for approximating solutions of ordinary differential equations (ODEs) and partial differential equations (PDEs). 2. To demonstrate students with the capability to deploy established approaches accurately to analyze and solve problems using a reasonable level of skill in calculation and manipulation of the material in the following areas: multistep methods, approximation of boundary value problems, finite difference methods.	
6	Course Outcomes	The student will be able to CO1: Recall numerical solution of DE using various available methods. CO2: Solve 1D BVPs using finite difference methods and discuss their convergence. CO3: Solve 2D elliptic PDEs using finite difference methods. CO4: Solve parabolic PDEs using finite difference methods. CO5: Solve hyperbolic PDEs using finite difference methods. CO6: Discuss the convergence and estimate error.	
7	Course Description	This course addresses students of all fields who are interested in numerical methods for ordinary and partial differential equations, with focus on a rigorous mathematical basis. Many modern and efficient approaches are presented, after fundamentals of numerical approximation are established. Of particular focus is on qualitative understanding of the considered ordinary and partial differential equation, fundamentals of finite difference, finite element, and spectral methods, and important concepts such as stability, convergence, and error analysis.	
8	**Outline syllabus**		**CO Mapping**
	Unit 1	**Introduction**	
	A	Single step methods	CO1
	B	Predictor-Corrector methods	CO1
	C	Boundary Value Problems of Differential Equations	CO1
	Unit 2	**Finite Difference Methods for 1D BVPs**	
	A	Fundamentals of Finite Difference Methods, Deriving FD Formulas	CO2
	B	Consistency, Stability, Convergence, and Error Estimates of FD Methods, FD Methods for General 1D BVPs	CO2, CO6
	C	The Grid Refinement Analysis Technique	CO2, CO6
	Unit 3	**Finite Difference Methods for 2D Elliptic PDEs**	
	A	Boundary and Compatibility Conditions, The Central Finite Difference Method for Poisson Equations	CO3

	B	The Maximum Principle and Error Analysis, Finite Difference Methods for General Second-order Elliptic PDEs, Solving the Resulting Linear System of Algebraic Equations	CO3, CO6
	C	Fourth-order Compact FD Scheme for Poisson Equations, Finite Difference Method for Poisson Equations in Polar Coordinates	CO3, CO6
	Unit 4	**Finite Difference Methods for Parabolic PDEs**	
	A	The Euler Methods, The Method of Lines, The Crank–Nicolson scheme	CO4
	B	Stability Analysis for Time-dependent Problems, FD Methods and Analysis for 2D Parabolic Equations	CO4, CO6
	C	The ADI Method, An Implicit–explicit Method for Diffusion and Advection Equations	CO4, CO6
	Unit 5	**Finite Difference Methods for Hyperbolic PDEs**	
	A	Characteristics and Boundary Conditions, Finite Difference Schemes	CO5
	B	The Modified PDE and Numerical Diffusion/Dispersion, The Lax–Wendroff Scheme and Other FD methods	CO5, CO6
	C	Numerical Boundary Conditions, Finite Difference Methods for Second-order Linear Hyperbolic PDEs, Some Commonly Used FD Methods for Linear System of Hyperbolic PDEs	CO5, CO6
	Mode of examination	Theory	
	Weightage Distribution	CA:25%; MSE:25% ESE:50%	
	Text book/s*	1. Zhilin Li, Zhonghua, and Tao Tang, Numerical Solution of Differential Equations, Cambridge University Press.	
	Other References	1. Fried, I., 2014. Numerical solution of differential equations. Academic Press.	

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CMS401.1	3	3	3	3	2	1					3	3	1	
CMS401.2	3	3	3	3	2	1					3	3	1	
CMS401.3	3	3	3	3	2	1					3	3	1	
CMS401.4	3	3	3	3	2	1					3	3	1	
CMS401.5	3	3	3	3	2	1					3	3	1	
CMS401.6	3	3	3	3	2	1					3	3	1	
Average	**3.0**	**3.0**	**3.0**	**3.0**	**2.0**	**1.0**					**3.0**	**3.0**	**1.0**	

Programme: B.Sc. (Hons./Hons. With Research) Mathematics		**Batch:2024-28** **Academic Year: 2027-28**	
Branch: Mathematics		**Semester: VIII**	
1	Course Code	**MDA155**	
2	Course Title	**Time Series, Forecasting and Index Number Lab**	
3	Credits	1	
4	Contact Hours (L-T-P)	0-0-2	
	Course Status	DSE	
5	Course Objective	1. To provide students with hands-on experience in working with time series data. This includes exploring different types of time series data, understanding their characteristics, and learning how to preprocess and clean the data for analysis. 2. To familiarize the students with visualizing time series data using various techniques such as line plots, scatter plots, seasonal plots, and decomposition plots. 3. To help students gain insights into the patterns, trends, and seasonal variations present in the data. 4. To familiarize the students with different time series modelling techniques, such as autoregressive integrated moving average (ARIMA) models, exponential smoothing models, or state space models. 5. The aim is to equip students with the knowledge and skills to select and apply appropriate models to analyze and forecast time series data.	
6	Course Outcomes	The student will be able to select and apply appropriate models to analyze and forecast time series data. CO1: To familiarize the students to enter time series data in Excel/R and do some data transformation and adjustments. (K1, K2, K3) CO2: To find basic descriptive of the data and determining the trend by various time series methods. (K1, K2, K3) CO3: To find the least square estimates of the linear regression model and also enable the students to check the model's adequacy. (K2, K3) CO4:To find the seasonal and cyclic variations in time series data.(K3, K4, K5) CO5: to predict new observations by applying ARIMA model (K4, K5, K6) CO6: To enable students in employing Partial autocorrelation function and Mixed auto-regressive moving average processes. (K4, K5, K6)	
7	Course Description	This is an advances course in statistics. Students are introduced to the f concepts involved in using sample data to make inferences about populations. Included are the study of measures of central tendency and dispersion, finite probability, statistical inferences from large and small samples, linear regression, and correlation and hypothesis.	
8	**Outline syllabus**		**CO Mapping**
	Unit 1	**Lab. Experiment 1**	
	A, B, C	Problem-based how to enter time series data in a column, with each observation in a separate cell. Ensure the data is sorted in chronological order. Data transformation and adjustments.	CO1
	Unit 2	**Lab. Experiment 2**	

	A, B, C	Problem-based on how to calculate basic descriptive statistics such as mean, median, and standard deviation. Analyze the data's trend by the method of the freehand curve, Moving average curve, semi-average curve, and least square method.	CO2
	Unit 3	**Lab. Experiment 3**	
	A, B, C	Problem-based on Least square estimation in the linear regression model.Model Adequacy checking. Regression models for general time series data. Prediction of new observations in time series data.	CO3
	Unit 4	**Lab. Experiment 4**	
	A, B, C	Problem-based on how to d etermine if data exhibits seasonality by calculating the seasonal indices. Methods for measuring linear trend Methods for measuring seasonal variations. Methods for measuring cyclic variations.	CO4
	Unit 5	**Lab. Experiment 5**	
	A, B, C	Problem-based on how to use software to built-in forecasting functions to generate predictions. Linear models for stationary time series. Calculations of moving averages (first and second order). General auto-regressive process. Partial autocorrelation function. Mixed auto-regressive moving average processes.	CO5, CO6
	Mode of examination	Practical+Viva	
	Weightage Distribution	CA:30%; CE:30%; ESE:40%	
	Text book/s*	1. Hyndman, R. J., & Athanasopoulos, G. (2018). Forecasting: principles and practice.	
	Other References	1. Time Series Modeling for Analysis and Control: Advanced Autoregressive Techniques" Dan L. Shunk	

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
MDA155.1	1	2	2	2		1	1	3	1			1	2	
MDA155.2	1	2	3	2		1	1	3	1			1	2	
MDA155.3	1	2	2	2		1	1	3	1			1	2	
MDA155.4	1	2	2	2		1	1	3	1			1	2	
MDA155.5	1	2	2	2		1	1	3	1			1	2	
MDA155.6	1	2	2	2		1	1	3	1			1	2	
Average	**1.0**	**2.0**	**2.0**	**2.0**		**1.0**	**1.0**	**3.0**	**1.0**			**1.0**	**2.0**	

School: SSBSR		**Batch: 2024-28**	
Programme: B.Sc. (Hons./Hons. With Research) Mathematics		**Academic Year: 2027-28**	
Branch: Mathematics		**Semester: VIII**	
1	Course Code	**CMS451**	
2	Course Title	**Numerical Solution of Differential Equations Lab**	
3	Credits	**1**	
4	Contact Hours (L-T-P)	**0-0-2**	
	Course Status	**DSE**	
5	Course Objective	1.To familiarize the students with basic concepts of numerical methods to find the solution of ODE and PDE. 2.To appreciate the use of numerical methods to a range of Engineering Problems.	
6	Course Outcomes	CO1: Summarize the solution methods of IVPs using single methods. CO2: Write and execute a code on solving 1D BVPs using finite difference methods. CO3: Write and execute a code on solving 2D elliptic PDEs using finite difference methods. CO4: Write and execute a code on solving parabolic PDEs using finite difference methods. CO5: Write and execute a code on solving hyperbolic PDEs using finite difference methods. CO6: Implement convergence criteria within code to check tolerance and estimate error.	
7	Course Description	This course is an introduction to the fundamental of finite elements methods. The primary objective of the course is to develop the basic understanding finite element formulations to solve one dimensional problem, two-dimensional scalar problems, two-dimensional Vector problems and solve problems on iso parametric element and dynamic problems.	
8	**Outline syllabus**		**CO Mapping**
	Unit 1	**Lab. Experiment 1-2:**	
		Introduction to numerical method to solve ODE. Solve using Picard's method, Euler's method and Runge Kutta method using software MATLAB.	CO1
	Unit 2	**Lab. Experiment 3-5:**	
		Consistency, Stability, Convergence, and Error Estimates of FD Methods, FD Methods for General 1D BVPs	CO2, CO6
	Unit 3	**Lab. Experiment 6-8:**	
		Boundary and Compatibility Conditions, The Central Finite Difference Method for Poisson Equations, Finite Difference Methods for General Second-order Elliptic PDEs	CO3, CO6
	Unit 4	**Lab. Experiment 9-10:**	
		The Crank–Nicolson scheme, Stability Analysis for Time-dependent Problems, FD Methods and Analysis for 2D Parabolic Equations, The ADI Method	CO4, CO6
	Unit 5	**Lab. Experiment 11-12:**	
		The Lax–Wendroff Scheme and Other FD methods, Some	CO5, CO6

		Commonly Used FD Methods for Linear System of Hyperbolic PDEs	
	Mode of examination	Lab	
	Weightage Distribution	CA: 30%; CE:30%; ETE:40%	
	Text book/s*	1. Icha, A., 2015. The Numerical Solution of Ordinary and Partial Differential Equations by Granville Sewell, World Scientific.	
	Other References	1. Fried, I., 2014. Numerical solution of differential equations. Academic Press.	

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CMS451.1	3	3	3	3	3	1	3	3	1		3	3	3	
CMS451.2	3	3	3	3	3	1	3	3	1		3	3	3	
CMS451.3	3	3	3	3	3	1	3	3	1		3	3	3	
CMS451.4	3	3	3	3	3	1	3	3	1		3	3	3	
CMS451.5	3	3	3	3	3	1	3	3	1		3	3	3	
Average	**3.0**	**3.0**	**3.0**	**3.0**	**3.0**	**1.0**	**3.0**	**3.0**	**1.0**		**3.0**	**3.0**	**3.0**	

School: SSBSR	**Batch: 2024-28**			
Program: M.Sc.	**Academic Year: 2027-28**			
Branch: Mathematics	**Semester: VIII**			
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
MTR454.1	3	2	3	3	2	3	2	3	3
MTR454.2	3	2	3	3	2	3	2	3	3
MTR454.3	3	3	3	3	3	3	2	3	3
MTR454.4	3	3	3	3	3	3	3	3	3
MTR454.5	3	3	3	3	3	3	3	3	3
MTR454.6	3	3	3	3	3	3	3	3	3

School: SSBSR		**Batch: 2024-28**	
Programme: B.Sc. (Hons./Hons. With Research) Mathematics		**Academic Year: 2027-28**	
Branch: Mathematics		**Semester: VIII**	
1	Course Code	**MMT205**	
2	Course Title	**Functional Analysis**	
3	Credits	**4**	
4	Contact Hours(L-T-P)	**4-0-0**	
	Course Status	**CC**	
5	Course Objective	To familiarize 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 $\square^n$; 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 andwrite 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 adjointoperator, 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 closedgraph theorems and Inner product spaces.	
8	Outline syllabus		CO Mapping
	Unit 1	**Normed linear spaces**	
	A	Normed linear spaces, Holder's inequality, Minkowski'sinequality	CO1

	B	l^p-spaces, equivalence of norms, equivalence of normson a finite dimensional space, Riesz lemma,	CO1
	C	Banach spaces, examples	CO1
	Unit 2	**Bounded linear operator**	
	A	Bounded linear operator, spaces of bounded linearoperator	CO2
	B	Finite dimensional normed space and compactness	CO2
	C	Dual of normed spaces $\square^n$; l^p also of C[a, b]).	CO2
	Unit 3	**Open mapping**	
	A	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	Inner product spaces, Hilbert spaces and examples	CO5
	B	Projection theorem, Bessel's inequality, existence ofcomplete orthonormal basis of a Hilbert space	CO5
	C	Riesz representation theorem	CO5
	Unit 5	**Bounded linear functional**	
	A	Bounded linear functional.	CO6
	B	Hilbert adjoint operator, self adjoint operator, Compactoperators	CO6
	C	Riesz-Schauder theorem, self-adjoint compact operators.	CO6
	Mode of examination	Theory	
	Weightage Distribution	CA:25%; MSE:25% ESE:50%	
	Text book/s*	1.Kreyszig, Erwin, Introductory Functional Analysis with Applications, Wiley Classics Library, John Wiley &Sons, Inc., New York, 1989.	
	Other References	1. J.B. Conway, " A course in Functional Analysis", Springer- Verlag, New York, 1990	

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
MMT205.1	1	3	2	3	3	1					1	1	3	
MMT205.2	1	3	2	3	3	1					1	1	3	
MMT205.3	1	3	2	3	3	1					1	1	3	
MMT205.4	1	3	2	3	3	1					1	1	3	
MMT205.5	1	3	2	3	3	1					1	1	3	
MMT205.6	1	3	2	3	3	1					1	1	3	
Average	**1.0**	**3.0**	**2.0**	**3.0**	**3.0**	**1.0**					**1.0**	**1.0**	**3.0**	

School: SSBSR		**Batch: 2024-28**	
Programme: B.SC		**Academic Year: 2027-28**	
Branch: Mathematics		**Semester:** VIII	
1	**Course Code**	MMT202	
2	**Course Title**	MEASURE THEORY	
3	**Credits**	**4**	
4	**Contact Hours (L-T-P)**	**4-0-0**	
	Course Status	**Minor**	
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 and calculate interior, exterior limit point and boundary points. (K2, K3, K4) CO2: Describe the concept of approximation of measurable functions, explain Lebesgue's monotone convergence theorem and Fatou's lemma and evaluate integration of positive functions, term by term differentiation of a series of positive measurable functions. (K1,K2, K5) CO3: Discuss the integration of complex function.(K1, K2) CO4: Explain Lebesgue's dominated convergence theorem, role of sets of measure zero, write extension of a measure to a complete measure. (K2,K4,K6) CO5: Explain integration as linear functional, Topological ingredients and write positive Borel measure, Hausdorff spaces. (K2, K3, K4, K6) CO6: Describe the concept locally compact Hausdorff spaces, support of a complex function, vector space of continuous complex functions with compact support and write 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, measurable functions	**CO1**
	C	lim sup and liminf of sequence of functions.	**CO1**
	Unit 2	**Lebesgue measure:**	
	A	Approximation of measurable functions by simple	**CO2**

		functions, positive measures			
	B	Integration of positive functions, Lebesgue's monotone convergence theorem			**CO2**
	C	Term by term differentiation of a series of positive measurable functions, Fatou's lemma.			**CO2**
	Unit 3	**Integration of complex functions:**			
	A	Complex measurable functions, integration of Complex measurable functions			**CO3**
	B	Lebesgue's dominated convergence theorem , role of sets of measure zero			**CO3, CO4**
	C	Extension of a measure to a complete measure.			**CO3, CO4**
	Unit 4	**Integration as a linear functional:**			
	A	Positive Borel measure, vector spaces			**CO5**
	B	Integration as a linear functional, Topological ingredients			**CO5**
	C	Definition of compactness and Hausdorff spaces.			**CO5**
	Unit 5	**Riesz representation theorem:**			
	A	Locally compact Hausdorff spaces, support of a complex function			**CO6**
	B	Vector space of continuous complex functions with compact support			**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 – PROGRAMMEME OUTCOMES MAPPING TABLE

PO / CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4
MMT202.1	3	3	3	3	3	3	3	2	1
MMT202.2	3	2	3	3	2	3	2	1	1
MMT202.3	2	2	2	2	2	2	2	1	1
MMT202.4	2	2	1	2	2	2	3	1	1
MMT202.5	3	2	2	3	3	3	2	2	2
MMT202.6	3	2	1	3	2	3	2	2	2

School: SSBSR		**Batch: 2024-28**	
Programme: M.Sc.		**Academic Year: 2027-28**	
Branch: Mathematics		**Semester: VII**	
1	Course Code	MTR4856	
2	Course Title	Research Project- II	
3	Credits	9	
4	Contact Hours (L-T-P)	0-0-18	
	Course Status	Project	
5	Course Objective	• Conduct detailed mathematical research with emphasis on originality and rigor. • Strengthen academic writing and oral presentation skills through dissertation writing and defense.	
6	Course Outcomes	CO1: Demonstrate comprehensive understanding of the selected topic through data analysis and theoretical application. (K4) CO2: Apply mathematical tools and advanced methodologies to solve the research problem. (K5) CO3: Prepare a structured, well-documented dissertation. (K5, K6) CO4: Present and defend research outcomes effectively. (K6) 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 involves conducting substantial and original research, data analysis, and producing a detailed dissertation. Students are expected to adhere to academic and ethical standards in research presentation and defense	
8	Outline syllabus		CO Achievement
	Unit 1	**Advanced Methodology & Data Collection** • Application of proposed research methods • Data acquisition (theoretical/computational/empirical)	**CO1**
	Unit 2	**Analysis and Interpretation** Applying appropriate analytical methods • Drawing conclusions and discussing implications	**CO1, CO2**
	Unit 3	**Dissertation Writing and Defense** • Academic writing practices • Structuring the final document • Oral presentation and defense	**CO2, CO3**

	Unit 4	**Data Collection and Analysis** • Implement data collection procedures in alignment with the proposed research methodology, where applicable. • Apply suitable and advanced mathematical tools for comprehensive data analysis. • Analyze and interpret findings in relation to the research objectives and the theoretical framework			**CO3, CO4**
	Unit 5	**Dissertation Writing and Defense** • Organize and compose a well-structured research dissertation or article. • Follow established academic conventions for writing, referencing, and citation styles. • Prepare for and effectively present the dissertation during the final defense session.			**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
MTR4856.1	3	3	2	2	2	3	2	3	3
MTR4856.2	2	3	3	2	3	2	3	3	2
MTR4856.3	2	3	2	2	3	3	3	3	3
MTR4856.4	2	3	2	2	2	3	2	3	2
MTR4856.5	2	2	2	3	3	3	3	3	3
MTR4856.6	2	2	2	3	3	3	3	3	3