Programme Structure

Sharda School of Basic Sciences & Research
Department of Mathematics

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

Programme Code: SBR0302

Batch 2023-27

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 ofacademic excellence, innovation and nurturing entrepreneurship.

Mission of the University

M1. Transformative educational experience.

M2. Enrichment by educational initiatives that encourage global outlook.

M3. Develop research, support disruptive innovations and accelerateentrepreneurship.

M4. Seeking beyond boundaries.

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 centre 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.

Vision and Mission of 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.

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

Programme Educational Objectives (PEOs)

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

PEO2. Develop critical thinking, creative thinking, 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.

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)

4-Year Course Structure of B. Sc. (Hons./ Hons. With Research) Mathematics

Department of Mathematics

		Subject 1	Subject 2	Subject 3		Subject4	Vocational	Co-curricular	Training/Survey/ Project/	{Minimum Credits} For the year	{Cumulative Minimum Credits} Required for Award of Certificate/ Diploma/ Degree
		Major 1	Major 2	Major 3		Minor/ Elective	Minor	Minor	Major		
		Credits (3/4//5)	Credits (3/4/5)	Credits (3/4//5)	Project	Credits (3/4/5)	Credits (3)	Credits (2)	Credits (2/3/4/8)		
		CC	CC	DSE		OPE	SEC	AEC	VAC		
Year	Sem.	Own Faculty	Own/inter or multidisciplinary Faculty	Any Faculty		Other subject/ Faculty	Vocational/Skill Development Course	Co-curricular course	Inter/Intra Faculty related to main Subject		
1	I	Maths (3+1)	X	Stats (3+1)	X	CS (3+1)	SEC (3)	SK (2)	VAC (3)	{40}	**{40}** **Certificate in Faculty**
	II	Maths (3+1)	CS (3+1)	X	X	Stats (3+1)	SEC (3)	SK (2)	VAC (3)		
2	III	Maths (3+1)	Maths (3+1)	Stats (3+1)	__RBL-1** (Audit)__	OPE-1 (3)	SEC (3)	SK (2)	X	{40}	**{80}** **Diploma in Faculty**
	IV	Maths (3+1)	Maths (4+1)	Stats (4+1)	__RBL-2** (Audit)__	OPE-2 (3+1)	X	SK (2)	X		

__** Courses are the audit courses. However, evaluation shall be made as per rubrics.__

Summer Industry Internship (Industry Connect) Course shall be conducted in the summer break of 04th Semester. However, evaluation will be made as per Rubrics in the 5th Semester "Industry Connect"											
3	V	Maths (4+1) Maths (4+1)	Maths (3+1)	Stats (2+1)	**RBL-3 (1)**	X	X	X	Industry Connect (2)	{40}	**{120}** **Bachelor Degree inFaculty**
	VI	Maths (4+1) Maths (4+1)	Stat (3+1) Math (3)	X	**RBL-4 (1)**	X	X	X	Community Connect (2)		
4	VII	Maths (3+1) Maths (3+1)	X	Maths (3+1) Maths (3+1)	X	OPE-3 (4)	X	X	X	{40}	**{160}** **Bachelor (Hons.) in Faculty**
	VIII	Maths (3+1) Maths (3+1) Maths (3+1)	X	Maths (3+1)	X	OPE-4 (4)	X	X	X		
4	VII	Maths (3+1)	X	Maths (3+1) Maths (3+1)	X	OPE-3 (4)	X	X	Dissertation-1 (4)	{40}	**{160}** **Bachelor (Hons. With Research) in Faculty**
	VIII	Maths (3+1)	X	Maths (3+1)	X	OPE-4 (4)	X	X	Dissertation-2 (8)		

^Maths-Mathematics course; Stats-Statistics course; CS-Computer Science course; SK-Sharda Skills course; SEC-Skill Enhancement Course; AEC-Ability Enhancement Course; VAC-Value Added Course; OPE-Open Elective course.

Programme Structure

B. Sc. (Hons./ Hons. With Research) Mathematics **Batch: 2023-27**

Term: 2301 (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 up to 10+2	CC
2.	CMS102	Descriptive Statistics	3	0	0	3	3	Basic Mathematics up to 10+2	OPE
3.	CSE113	Programming for Problem Solving	3	0	0	3	3		DSE (Multi/Inter-discpli)
4.	VOM103	Essential Excel Skills for Business	0	0	6	6	3		SEC
5.	ARP101	Communicative English-1	1	0	2	3	2		AEC
6.	VAC103	Environmental Management	3	0	0	3	3		VAC
	PRACTICALS								
7.	CMS151	Foundation Course in Mathematics Lab	0	0	2	2	1	Co-requisite MSM101	CC
8.	CSP113	Programming for Problem Solving Lab	0	0	2	2	1	Co-requisite CSE113	DSE (Multi/Inter-discpli)
TOTAL CREDITS							**20**		

Programme Structure

B. Sc. (Hons./ Hons. With Research) Mathematics Batch: 2023-27

TERM: 2302 (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.	CMS132	Mathematical Expectations & Probability Distributions	3	0	0	3	3	Pre-requisite CMS102	OPE
3.	CSE242	Data Structures	3	0	0	3	3	Pre-requisite CSE113	CC
4.	VOM104	Advanced Excel Skills for Business	0	0	6	6	3	Pre-requisite VOM103	SEC
5.	ARP102	Communicative English-2	1	0	2	3	2	Pre-requisite ARP101	AEC
6.	VAC110	Yoga for Holistic Health	0	1	4	5	3		VAC
	PRACTICALS								
7.	CMS171	Matrix Analysis and Linear Algebra Lab	0	0	2	2	1	Co-requisite CMS131	CC
8.	CSP242	Data Structures Lab	0	0	2	2	1	Co-requisite CSE113	CC
		TOTAL CREDITS					**20**		

Programme Structure

B. Sc. (Hons./ Hons. With Research) Mathematics **Batch: 2023-27**

TERM: 2401 (Semester-III)

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.	CMS201	Abstract Algebra	5	0	0	5	5	Pre-requisite MSM101	CC
2.	CMS202	Calculus	3	0	0	3	3	Pre-requisite MSM101	CC
3.	BDA216/ BDA217	Statistical Inference/ Data Preparation and Data Cleaning	3	0	0	3	3	Pre-requisite CMS132	DSE
4.	OPE	Open Elective-1	3	0	0	3	3		OPE
5.	VOM203	Basic Excel Modelling	0	0	6	6	3	Pre-requisite VOM104	SEC
6.	ARP207	Logical Skills Building and Soft Skills	0	1	2	3	2	Pre-requisite ARP102	AEC
	PRACTICALS								
7.	CMS251	Calculus Lab	0	0	2	2	1	Co-requisite CMS202	CC
8.	BDA261/ BDA262	Statistical Inference Lab/ Data Preparation and Data Cleaning Lab	0	0	2	2	1		DSE
9.	RBL001	Research Based Learning-I (RBL-1)	0	0	2	2	0	Pre-requisite ARP102	Project (Non-graded Qualifying)
		TOTAL CREDITS					**21**		

Programme Structure

B. Sc. (Hons./ Hons. With Research) Mathematics Batch: 2023-27

TERM: 2402 (Semester-IV)

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.	CMS231	Real Analysis	4	0	0	4	4	Pre-requisite MSM101	CC
2.	CMS232	Ordinary Differential Equations and Laplace Transforms	4	0	0	4	4	Pre-requisite CMS202	CC
3.	BDA214/ BDA202	Sampling Theory/ Data Base Management Systems	4	0	0	4	4		DSE
4.	OPE	Open Elective-2	3	0	0	3	3		OPE
5.	ARP306	Campus to Corporate	0	1	2	3	2	AEC	AEC
	PRACTICALS								
6.	CMS271	Ordinary Differential Equations and Laplace Transforms Lab	0	0	2	2	1	Co-requisite CMS232	CC
7.	BDA272/ BDA271	Sampling Theory Lab/ Data Base Management Systems Lab	0	0	2	2	1		DSE
8.	RBL002	Research Based Learning-II (RBL-2)	0	0	2	2	0	Pre-requisite RBL001	Project
TOTAL CREDITS							**19**		

Programme Structure

B. Sc. (Hons./ Hons. With Research) Mathematics **Batch: 2023-27**

TERM: 2501 (Semester-V)

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.	CMS301	Complex Analysis	5	0	0	5	5	Pre-requisite CMS231	CC
2.	CMS302	Mathematical Modelling	4	0	0	4	4	Pre-requisite CMS232	CC
3.	CMS303	Discrete Mathematics	4	0	0	4	4	Pre-requisite MSM101	CC
4.	BDA320/ BDA321	Advanced Statistical Analysis/ Experimental Design	2	0	0	2	2		DSE (Multi/Inter-discpli)
	PRACTICALS								
5.	CMS351	Mathematical Modelling Lab	0	0	2	2	1	Co-requisite CMS302	CC
6.	BDA359/ BDA363	Advanced Statistical Analysis Lab/ Experimental Design Lab	0	0	2	2	1		DSE (Multi/Inter-discpli)
7.	INC001	Industry Connect	0	0	4	4	2		Project
8.	RBL003	Research Based Learning-III (RBL-3)	0	0	2	2	1	Pre-requisite RBL002	Project
TOTAL CREDITS							**20**		

Programme Structure

B. Sc. (Hons./ Hons. With Research) Mathematics **Batch: 2023-27**

TERM: 2502 (Semester-VI)

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.	CMS331	Numerical Methods	4	0	0	4	4	Pre-requisite CMS202, 231	CC
2.	CMS332	Introduction to Partial Differential Equations	4	0	0	4	4	Pre-requisite CMS232	CC
3	CMS333	Graph Theory	3	0	0	3	3	Pre-requisite CMS303	OPE
4.	BDA323	Multivariate Data Analysis	3	0	0	3	3	Pre-requisite CMS132	CC
	PRACTICALS								
5.	CMS371	Numerical Methods Lab	0	0	2	2	1	Co-requisite CMS331	CC
6.	CMS372	Introduction to Partial Differential Equations Lab	0	0	2	2	1	Co-requisite CMS332	CC
7.	BDA361	Multivariate Data Analysis Lab	0	0	2	2	1	Co-requisite CMS323	CC
8.	RBL004	Research Based Learning-IV (RBL-4)	0	0	2	2	1	Pre-requisite RBL003	Project
9.	CCU108	Community Connect	0	0	4	4	2	Project	Project (Multi/Inter-discpli)
		TOTAL CREDITS					**20**		

Programme Structure

B. Sc. (Hons./ Hons. With Research) Mathematics **Batch: 2023-27**

TERM: 2601 (Semester-VII)

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.	CMS401	Numerical Solution of Differential Equations	3	0	0	3	3	Pre-requisite CMS232, 331,332	CC
2.	CMS403	Number Theory	4	0	0	4	4	Pre-requisite CMS303	CC
3.	MDA110/ MDA112	Time Series, Forecasting and Index Number/ Econometrics	3	0	0	3	3		DSE/CC*
4.	MDA111/ MDA113/ MMT107/ MMT202/ CMS405/ CMS406/ CMS404/ CMS407	Non-Parametric Statistical Inference/ Survival Analysis/ Topology (NPTEL)/ Measure Theory (NPTEL)/ Computational Commutative Algebra (NPTEL)/ Measure and Integration (NPTEL)/ Introduction to Methods of Applied Mathematics (NPTEL)/ Competitive Mathematics (NPTEL)	4	0	0	4	4		DSE/CC*
5.	OPE	Open Elective-3	4	0	0	4	4		OPE
	PRACTICALS								

6.	CMS451	Numerical Solution of Differential Equations Lab	0	0	2	2	1	Co-requisite CMS401	CC
7.	MDA155/ MDA156	Time Series, Forecasting and Index Number Lab/ Econometrics Lab	0	0	2	2	1		DSE/CC*
TOTAL CREDITS							**20**		

***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.**

Programme Structure

B. Sc. (Hons./ Hons. With Research) Mathematics Batch: 2023-27

TERM: 2602 (Semester-VIII)

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.	CMS431	Finite Element Methods	4	0	0	4	4	Pre-requisite CMS401	CC
2.	CMS432	Optimization Techniques	4	0	0	4	4	Pre-requisite CMS131,202,232	CC
3.	CMS433	Integral Equations & Calculus of Variations	4	0	0	4	4	Pre-requisite CMS131,202,232	CC
4.	MDA115/ MDA116/ MMT205/ CMS435/ CMS436/ CMS437	Demography/ Statistical Quality Control/ Functional Analysis/ Algebraic Combinatorics/ Fourier Analysis and its Applications/ Applied Linear Algebra in AI and ML	4	0	0	4	4		DSE/CC*
5.	OPE	Open Elective-4	4	0	0	4	4		OPE
	PRACTICALS								
TOTAL CREDITS							**20**		

***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	OPE	SEC	AEC	VAC	Project	Mathematics	Computer Science	Statistics
1	4	4	4	3	2	3	0	4	4	4
2	8	0	4	3	2	3	0	4	4	4
3	8	4	3	3	2	0	0	8	0	4
4	9	5	4	0	2	0	0	9	0	5
5	14	3	0	0	0	0	3	14	0	3
6	17	0	0	0	0	0	3	13	0	4
Total:	60	16	15	9	8	6	6	52	8	24
%	**50**	**13.33**	**12.5**	**7.5**	**6.67**	**5**	**5**	**43.33**	**6.67**	**20**
7	8	8	4	0	0	0	0	16	0	0
8	12	4	4	0	0	0	0	16	0	0
Total:	80	28	23	9	8	6	6	84	8	24
%	**50**	**17.5**	**14.38**	**5.63**	**5**	**3.75**	**3.75**	**52.5**	**5**	**15**

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	Time Series, Forecasting and Index Number (3-0-0)

		MDA155	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

COURSE MODULE

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
VOM207		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

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**
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
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)

School: SSBSR		**Batch: 2023-27**	
Programme: B.Sc. (Hons.)		**Academic Year: 2023-24**	
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: 2023-27**	
Programme: B.Sc. (Hons.)		**Academic Year: 2023-24**	
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 communicate quantitative data verbally, graphically, symbolically and numerically. 2. To make students familiar with the concept of Probability and Statistics and display data utilizing various 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 appropriate diagrams, 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 linear regression 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 grouped data.	CO1
		Frequency distributions, cumulative frequency distributions	CO1

	B		
	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: 2023-27**	
Programme: B.Sc. (Hons.)		**Academic Year: 2023-2024**	
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 and keywords, 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.	

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**
CSE113.1	1	2	2	3								1		
CSE113.2	1	_2	2	3								1		
CSE113.3	1	2	2	3								1		
CSE113.4	1	2	2	3								1		
CSE113.5	1	2	2	3								1		
CSE113.6	1	2	2	3								1		
Average	**1.0**	**2.0**	**2.0**	**3.0**								**1.0**		

School: SSBSR		**Batch: 2023-27**	
Programme: B.Sc. (Hons.)		**Academic Year: 2023-24**	
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.	

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**
VOM103.1		2	1	2		1		3				1		1
VOM103.2		2	1	2		1		3				1		1
VOM103.3		2	1	2		1		3				1		1
VOM103.4		2	1	2		1		3				1		1
VOM103.5		2	1	2		1		3				1		1
VOM103.6		2	1	2		1		3				1		1
Average		**2.0**	**1.0**	**2.0**		**1.0**		**3.0**				**1.0**		**1.0**

School: SSBSR		**Batch :** 2023-27	
		Academic Year: 2023-24	
		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 Earth (Watching a Full length Feature Film)	CO2, 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: 2023-27**	
Programme: B.Sc. (Hons.)		**Academic Year: 2023-2024**	
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	

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO	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
VAC103.1	1	2		_	1	2			2	3	1			
VAC103.2	1	3			2	2			2	3	1			
VAC103.3	2	1			3	3			1	3	_1			
VAC103.4	1	2			2	2			1	2	1			
VAC103.5	1	2			3	2			2	3	1			
VAC103.6	1	2			2	3			1	2	1			
Average	**1.2**	**2.0**			**2.2**	**2.3**			**1.5**	**2.7**	**1.0**			

School: SSBSR		**Batch: 2023-27**	
Programme: B.Sc. (Hons.)		**Academic Year: 2023-24**	
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 (vi)1 ;n ∈ N X 2n	CO1
	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.	

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
CMS151.1	1	2	2	2		1	1	3	1		1	1		2
CMS151.2	1	2	3	2		1	1	3	1		1	1		2
CMS151.3	1	2	2	2		1	1	3	1		1	1		2
CMS151.4	1	2	2	2		1	1	3	1		1	1		2
CMS151.5	1	2	2	2		1	1	3	1		1	1		2
CMS151.6	1	2	2	2		1	1	3	1		1	1		2
Average	**1.0**	**2.0**	**2.0**	**2.0**		**1.0**	**1.0**	**3.0**	**1.0**		**1.0**	**1.0**		**2.0**

School: SSBSR		**Batch: 2023-27**	
Programme: B.Sc. (Hons.)		**Academic Year: 2023-2024**	
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.	

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
CSP113.1	3	3	2	3	2	3	2	3	2	2	1	1	-	1
CSP113.2	2	3	3	3	3	2	3	2	2	2	1	1	-	1
CSP113.3	2	3	2	2	2	2	3	3	2	2	1	1	-	1
CSP113.4	2	3	2	3	2	3	2	2	3	2	1	1	-	1
CSP113.5	2	3	2	2	2	2	3	3	2	2	1	1	-	1
CSP113.6	2	3	2	3	2	3	2	2	3	2	1	1	-	1
Average	**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**

School: SSBSR		**Batch: 2023-27**	
Programme: B.Sc. (Hons.)		**Academic Year: 2023-24**	
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 Nullity, Rank-Nullity Theorem.	CO 3, CO 4
	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	2	-
CMS131.2	3	2	2	2	-	1	-	-	-	-	2	1	2	-
CMS131.3	3	2	3	3	-	1	-	-	-	-	2	1	2	-
CMS131.4	3	2	2	3	-	1	-	-	-	-	2	1	2	-
CMS131.5	3	2	2	3	-	1	-	-	-	-	2	1	2	-
CMS131.6	3	2	2	3	-	1	-	-	-	-	2	1	2	-
Average	**3.0**	**2.0**	**2.0**	**2.6**	**-**	**1.0**	**-**	**-**	**-**	**-**	**2.0**	**1.0**	**2.0**	**-**

School: SSBSR		**Batch: 2023-27**	
Programme: B.Sc. (Hons.)		**Academic Year: 2023-24**	
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	CO1

		generating function, probability generating function.	
	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	1	-
CMS132.2	-	1	-	2	-	-	-	-	-	-	2	1	1	-
CMS132.3	-	1	-	2	-	-	-	-	-	-	2	1	1	-
CMS132.4	-	1	-	2	-	-	-	-	-	-	2	1	1	-
CMS132.5	-	1	-	2	-	-	-	-	-	-	2	1	1	-
CMS132.6	-	1	-	2	-	-	-	-	-	-	2	1	1	-
Average	**-**	**1.0**	**-**	**2.0**	**-**	**-**	**-**	**-**	**-**	**-**	**2.0**	**1.0**	**1.0**	**-**

School: SSBSR		**Batch: 2023-27**	
Programme: B.Sc. (Hons.)		**Academic Year: 2023-2024**	
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 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			**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	

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**
CSE242.1	2	3	2	2	-	-	-	-	-	-	1	-	-	1
CSE242.2	2	3	2	2	-	-	-	-	-	-	1	-	-	1
CSE242.3	2	3	2	2	-	-	-	-	-	-	1	-	-	1
CSE242.4	2	3	2	2	-	-	-	-	-	-	1	-	-	1
CSE242.5	2	3	2	2	-	-	-	-	-	-	1	-	-	1
CSE242.6	2	3	2	2	-	-	-	-	-	-	1	-	-	1
Average	**2.0**	**2.3**	**2.0**	**2.0**	**-**	**-**	**-**	**-**	**-**	**-**	**1.0**	**-**	**-**	**1.0**

School: SSBSR		**Batch: 2023-27**	
Programme: B.Sc. (Hons.)		**Academic Year: 2023-24**	
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	**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**
CO														
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 : 2023-2027**	
		Current Academic Year: 2023-2024	
		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, Monothongs, Dipthongs and Tripthongs	CO3

	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: 2023-27**	
Programme: B.Sc. (Hons.)		**Academic Year: 2023-24**	
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, ch 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,	CO3, CO4, CO5, CO6

		Pragya Yoga (Shantikunj), Iyengar Yoga, Patanjali Yoga Peeth, 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 Distributio	CA:60%; ESE:40%	

	n		
	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: 2023-27**	
Programme: B.Sc. (Hons.)		**Academic Year: 2023-24**	
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.	

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
CMS171.1	1	2	2	2	-	1	1	3	1	-	1	1	-	2
CMS171.2	1	2	3	2	-	1	1	3	1	-	1	1	-	2
CMS171.3	1	2	2	2	-	1	1	3	1	-	1	1	-	2
CMS171.4	1	2	2	2	-	1	1	3	1	-	1	1	-	2
CMS171.5	1	2	2	2	-	1	1	3	1	-	1	1	-	2
CMS171.6	1	2	2	2	-	1	1	3	1	-	1	1	-	2
Average	**1.0**	**2.0**	**2.0**	**2.0**	**-**	**1.0**	**1.0**	**3.0**	**1.0**	**-**	**1.0**	**1.0**	**-**	**2.0**

School: SSBSR		**Batch: 2023-27**	
Programme: B.Sc. (Hons.)		**Academic Year: 2023-2024**	
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 DataStructures. 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:**Develop** 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	

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**
CSP242.1	1	2	2	2	-	1	1	3	1	-	-	-	-	1
CSP242.2	1	2	3	2	-	1	1	3	1	-	-	-	-	1
CSP242.3	1	2	2	2	-	1	1	3	1	-	-	-	-	1
CSP242.4	1	2	2	2	-	1	1	3	1	-	-	-	-	1
CSP242.5	1	2	2	2	-	1	1	3	1	-	-	-	-	1
CSP242.6	1	2	2	2	-	1	1	3	1	-	-	-	-	1
Average	**1.0**	**2.0**	**2.0**	**2.0**	**-**	**1.0**	**1.0**	**3.0**	**1.0**	**-**	**-**	**-**	**-**	**1.0**

Detailed Syllabus for

DIPLOMA IN MATHEMATICS

School: SSBSR		**Batch: 2023-27**	
Programme: B.Sc. (Hons.)		**Academic Year: 2024-25**	
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%; ESE:75%	
	Text book/s*	1. 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	PO	PO	PO	PO	PO	PO	PO	PO	PO	PO	PS	PSO	PSO	PSO
CO	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**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: 2023-27**	
Programme: B.Sc. (Hons.)		**Academic Year: 2024-25**	
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
		Successive differentiation and its applications, Leibnitz's theorem.	CO1

	B		
	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%; ESE:75%	
	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	2	2	2
CMS202.2	3	3	2	2	-	1	-	-	-	-	2	2	2	2
CMS202.3	3	3	2	2	-	1	-	-	-	-	2	2	2	2
CMS202.4	3	3	2	2	-	1	-	-	-	-	2	2	2	2
CMS202.5	3	3	2	2	-	1	-	-	-	-	2	2	2	2
CMS202.6	3	3	2	2	-	1	-	-	-	-	2	2	2	2
Average	**3.0**	**3.0**	**2.0**	**2.0**	**-**	**1.0**	**-**	**-**	**-**	**-**	**2.0**	**2.0**	**2.0**	**2.0**

School: SSBSR		**Batch: 2023-27**	
Programme: B.Sc. (Hons.)		**Academic Year: 2023-24**	
Branch: Mathematics		**Semester: III**	
1	Course Code	**RBL001**	
2	Course Title	**Research Based Learning-1**	
3	Credits	0	
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. Develop communication skills, especially in project writing and oral presentation. Develop some time management skills.	
6	Course Outcomes	CO1: Explain the concept of research within the subject, as regards approaching a question, collecting and 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, K6) CO4: Develop effective project organizational skills. (K5) CO5: Analyse the problem and summarize research findings. (K4,K5) CO6: Use 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**	**CO1**
	Unit 2	**Case study**	**CO1,CO2**
	Unit 3	**Conceptual**	**CO2,CO3**
	Unit 4	**Development**	**CO3**
	Unit 5	**Finalization**	**CO3,CO4**

	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**
RBL001.1	3	3	2	2	-	1	-	-	-	-	-	-	-	-
RBL001.2	2	3	3	2	-	1	-	-	-	-	-	-	-	-
RBL001.3	2	2	2	3	-	1	-	-	-	-	-	-	-	-
RBL001.4	2	3	2	2	-	1	-	-	-	-	-	-	-	-
RBL001.5	3	3	2	2	-	1	-	-	-	-	-	-	-	-
RBL001.6	3	3	2	3	-	1	-	-	-	-	-	-	-	-
Average	**2.3**	**2.6**	**2.0**	**2.1**	**-**	**1.0**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

School: SSBSR		**Batch: 2023-27**	
Programme: B.Sc. (Hons.)		**Academic Year: 2024-25**	
Branch: Mathematics		**Semester: III**	
1	Course Code	**VOM203**	
2	Course Title	**Basic Excel Modelling**	
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: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**
VOM203.1	-	2	1	2	-	1	-	3	-	-	-	-	1	1
VOM203.2	-	2	1	2	-	1	-	3	-	-	-	-	1	1
VOM203.3	-	2	1	2	-	1	-	3	-	-	-	-	1	1
VOM203.4	-	2	1	2	-	1	-	3	-	-	-	-	1	1
VOM203.5	-	2	1	2	-	1	-	3	-	-	-	-	1	1
VOM203.6	-	2	1	2	-	1	-	3	-	-	-	-	1	1
Average	**-**	**2.0**	**1.0**	**2.0**	**-**	**1.0**	**-**	**3.0**	**-**	**-**	**-**	**-**	**1.0**	**1.0**

School: SSBSR		**Batch: 2023-27**	
Programme: B.Sc. (Hons.)		**Academic Year: 2024-25**	
Branch: Mathematics		**Semester: III**	
1	Course Code	**ARP207**	
2	Course Title	**Logical Skill Building and Soft Skills**	
3	Credits	2	
4	Contact Hours (L-T-P)	0-1-2	
	Course Status	AEC	
5	Course Objective	To enhance the holistic development of students and improve their employability skills. To provide a 360-degree exposure to learning elements of the Business English readiness program, behavioral traits, achieve softer communication levels and a positive self-branding along with augmenting numerical and altitudinal abilities. To step up skill and upgrade students across varied industry needs to enhance employability skills. By the end of this semester, a student will have entered the threshold of his/her 1st phase of employability enhancement and skill-building activity exercise.	
6	Course Outcomes	After completion of this course, students will be able to: CO1: Ascertain a competency level through Building Essential Language and Life Skills CO2: Build positive emotional competence in self and learn GOAL Setting and SMART Goals techniques CO3: Apply positive thinking, goal setting and success-focused attitudes, time Management, which would help them in their academic as well as professional career CO4: Acquire satisfactory competency in use of aptitude, logical and analytical reasoning CO5: Develop strategic thinking and diverse mathematical concepts through building number puzzles CO6: Demonstrate an ability to apply various quantitative aptitude tools for making business decisions	
7	Course Description	This Level 1 blended training approach equips the students for Industry employment readiness and combines elements of soft skills and numerical abilities to achieve this purpose.	
8	**Outline syllabus**		**CO Mapping**
	Unit 1		
	A	Know Yourself: Core Competence. A very unique and interactive approach through an engaging questionnaire to ascertain a student's current skill level to design, architect, and expose a student to the right syllabus and also to identify the correct TNI/TNA levels of the student.	CO1
		Techniques of Self-Awareness | Self-Esteem & Effectiveness|	

	B	Building Positive Attitude | Building Emotional Competence	CO1, CO2
	C	Positive Thinking & Attitude Building | Goal Setting and SMART Goals – Milestone Mapping | Enhancing L S R W G and P (Listening Speaking Reading Writing Grammar and Pronunciation) |	CO1, CO2,CO3
	Unit 2	**Introduction to APTITUDE TRAINING- Reasoning- Logical/ Analytical**	
	A	Syllogism | Letter Series | Coding, Decoding, Ranking & Their Comparison Level-1	CO4
	B	Number Puzzles	CO5
	C	Selection Based On Given Conditions	CO5
	Unit 3	**Quantitative Aptitude**	
	A	Number Systems Level 1 | Vedic Maths Level-1	CO6
	B	Percentage,	CO6
	C	Ratio & Proportion | Mensuration - Area & Volume |Algebra	
	Unit 4	**Verbal Abilities – 1**	CO1
	A	Reading Comprehension	CO2
	B	Spotting the Errors	
	Unit 5	**Time & Priority Management**	CO3
	A	Steven Covey Time Management Matrix	CO3
	B	Creating Self Time Management Tracker	
	Mode of examination		
	Weightage Distribution	Class Assignment/Free Speech Exercises / JAM – 60% | Group Presentations/Mock Interviews/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	
	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
ARP207.1	1	2	2	2	-	1	1	3	1	-	-	1	2	-
ARP207.2	1	2	3	2	-	1	1	3	1	-	-	1	2	-
ARP207.3	1	2	2	2	-	1	1	3	1	-	-	1	2	-
ARP207.4	1	2	2	2	-	1	1	3	1	-	-	1	2	-
ARP207.5	1	2	2	2	-	1	1	3	1	-	-	1	2	-
ARP207.6	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: 2023-27**	
Programme: B.Sc. (Hons.)		**Academic Year: 2024-25**	
Branch: Mathematics		**Semester: III**	
1	Course Code	**CMS251**	
2	Course Title	**Calculus 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 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	CO1

		Taylor's theorem and Maclaurin's theorem, Maxima-minima and Points of inflexion.	
	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:25%; CE:25%; ESE:50%	
	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	2	2	2
CMS251.2	2	2	3	2	-	1	1	3	1	1	1	2	2	2
CMS251.3	2	2	2	2	-	1	1	3	1	1	1	2	2	2
CMS2514	2	2	2	2	-	1	1	3	1	1	1	2	2	2
CMS251.5	2	2	2	2	-	1	1	3	1	1	1	2	2	2
CMS251.6	2	2	2	2	-	1	1	3	1	1	1	2	2	2
Average	**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**

School: SSBSR		**Batch: 2023-2027**	
Programme: B.Sc(Hons)		**Academic Year: 2024-25**	
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 alsointroduced.	
6	Course Outcomes	**CO1:** Discuss the basic concepts of set theory on R, open & closed sets, bounded & unboundedsets, 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-convergentsequence, 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, Supremumand 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 continuousfunctions 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 decreasingfunctions	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%; ESE:75%	
	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 – 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
CMS231.1	1	3	2	3	3	1	-	-	-	-	1	1	3	-
CMS231.2	1	3	2	3	3	1	-	-	-	-	1	1	3	-
CMS231.3	1	3	2	3	3	1	-	-	-	-	1	1	3	-
CMS231.4	1	3	2	3	3	1	-	-	-	-	1	1	3	-
CMS231.5	1	3	2	3	3	1	-	-	-	-	1	1	3	-
CMS231.6	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: 2023-27**	
Programme: B.Sc. (Hons.)		**Academic Year: 2024-25**	
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 the course 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%; ESE:75%	
	Text book/s*	1.) S. L. Ross, Differential Equations, 3^{rd} 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	2	-
CMS2321.2	2	3	2	2	2	1	-	-	-	-	2	2	2	-
CMS232.3	3	3	2	3	2	1	-	-	-	-	2	2	2	-
CMS232.4	2	3	3	3	2	1	-	-	-	-	2	2	2	-
CMS232.5	2	3	3	3	2	1	-	-	-	-	2	2	2	-
CMS232.6	3	3	3	3	2	1	-	-	-	-	2	2	2	-
Average	**2.0**	**3.0**	**2.5**	**2.6**	**2.0**	**1.0**	**-**	**-**	**-**	**-**	**2.0**	**2.0**	**2.0**	**-**

School: SSBSR		**Batch: 2023-27**	
Programme: B.Sc. (Hons.)		**Academic Year: 2024-25**	
Branch: Mathematics		**Semester: IV**	
1	Course Code	**RBL002**	
2	Course Title	**Research-Based Learning-2**	
3	Credits	0	
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. Develop communication skills, especially in project writing and oral presentation. Develop some time management skills.	
6	Course Outcomes	CO1: Explain the concept of research within the subject, as regards approaching a question, collecting and 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, K6) CO4: Develop effective project organizational skills. (K5) CO5: Analyse the problem and summarize research findings. (K4,K5) CO6: Use 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**	**CO1**
	Unit 2	**Case study**	**CO1,CO2**
	Unit 3	**Conceptual**	**CO2,CO3**
	Unit 4	**Development**	**CO3**
	Unit 5	**Finalisation**	**CO3,CO4**

	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
RBL002.1	3	3	2	2	-	1	-	-	-	-	-	-	-	-
RBL002.2	2	3	3	2	-	1	-	-	-	-	-	-	-	-
RBL002.3	2	2	2	3	-	1	-	-	-	-	-	-	-	-
RBL002.4	2	3	2	2	-	1	-	-	-	-	-	-	-	-
RBL002.5	3	3	2	2	-	1	-	-	-	-	-	-	-	-
RBL002.6	3	3	2	3	-	1	-	-	-	-	-	-	-	-
Average	**2.3**	**2.6**	**2.0**	**2.1**	**-**	**1.0**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

School: SSBSR		**Batch: 2023-2027**	
Program: B.Sc. (Hons.)		**Academic Year: 2024-25**	
Branch: Mathematics		**Semester: IV**	
1	Course Code	**ARP306**	
2	Course Title	**Campus to Corporate**	
3	Credits	**2**	
4	Contact Hours (L-T-P)	**0-1-2**	
	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	CO1, CO3

		Noticed | Writing Cover Letters | Relationship Management	
	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	**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**
CO														
ARP306.1	-	-	-	-	-	3	-	-	1	3	-	2	-	-
ARP306.2	-	-	-	-	-	3	-	-	1	3	-	2	-	-
ARP306.3	-	-	-	-	-	3	-	-	1	3	-	2	-	-
ARP306.4	-	-	-	-	-	3	-	-	1	2	1	2	-	-
ARP306.5	-	-	-	-	-	3	-	-	1	2	1	2	-	-
ARP306.6	-	-	-	-	-	3	-	-	1	2	1	2	-	-
Average	**-**	**-**	**-**	**-**	**-**	**3.0**	**-**	**-**	**1**	**2.5**	**1**	**2**	**-**	**-**

School: SSBSR		**Batch: 2023-27**	
Programme: B.Sc. (Hons.)		**Academic Year: 2024-25**	
Branch: Mathematics		**Semester: IV**	
1	Course Code	**CMS271**	
2	Course Title	**Ordinary Differential Equations and Laplace Transforms Lab**	
3	Credits	1	
4	Contact Hours (L-T-P)	0-0-2	
	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 but not of first-degree Differential Equations.	CO 1
	Unit 2	**Higher order ODE**	

	A, B, C	3.) Higher order linear Differential Equations with constant coefficient.	CO 2
	Unit 3	**Simultaneous ODE**	
	A, B, C	4.) Method of Variation of parameters, 5.) Cauchy-Euler form of Differential Equations, 6.) Ordinary Simultaneous Differential Equations.	CO 3, CO 6
	Unit 4	**Laplace Transforms**	
	A, B, C	7.) Laplace Transforms and Inverse Laplace Transforms, 8.) Laplace transforms of Derivatives, 9.) Laplace Transforms of Integrals.	CO 4
	Unit 5	**Application of Laplace Transform**	
	A, B, C	10.) Solution of Initial Value Problem using Laplace Transform,	CO 5, CO 6
	Mode of examination	Practical + viva	
	Weightage Distribution	CA:25%; CE:25%; ESE:50%	
	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**
CMS271.1	3	3	2	3	1	1	1	3	1	1	2	1	2	-
CMS271.2	3	3	2	3	1	1	1	3	1	1	2	1	2	-
CMS271.3	3	3	2	3	1	1	1	3	1	1	2	1	2	-
CMS271.4	3	3	2	3	1	1	1	3	1	1	2	1	2	-
CMS271.5	3	3	2	3	1	1	1	3	1	1	2	1	2	-
CMS271.6	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**	**-**

Detailed Syllabus for

DEGREE IN

MATHEMATICS

School: SSBSR		**Batch: 2023-27**	
Programme: B.Sc. (Hons.)		**Academic Year: 2025-26**	
Branch: Mathematics		**Semester: V**	
1	Course Code	**CMS301**	
2	Course Title	**Complex Analysis**	
3	Credits	5	
4	Contact Hours (L-T-P)	5-0-0	
	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 analyses the derivative of a function. CO2: Evaluate a contour integral using parameterization, fundamental theorem of calculus and Cauchy's integral formula. CO3: Develop the Taylor's and Laurent's series of a function and evaluate its circle or annulus of convergence. CO4: Calculate the residue of a function and use the residue theory to evaluate a contour integral or an integral over the real line. CO5: Demonstrate the understanding of conformal mappings and Construct conformal mappings between many kinds of domain. CO6: Recognize and assess the applications of complex variables.	
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	**Analytic Functions and Cauchy-Riemann Equations**	
	A	Complex functions and their limits, continuity, differentiability,	CO1
	B	Analytic function, The C-R equations and sufficient conditions for	CO1

		differentiability and analyticity	
	C	Harmonic functions and harmonic conjugates.	CO1
	Unit 2	**Cauchy’s Theorems, Series and Singularities**	
	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	**Residues, Definite and Indefinite Integral**	
	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	**Mappings**	
	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	**Flow Problems, Modelling and Applications**	
	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%; ESE:75%	
	Text book/s*	1. Churchill, Ruel V. and Brown, JamesWard, Complex Variables and Applications, fourth edition, McGraw-Hill Book Co., New York, 1984.	
	Other References	1. Schaum's Outline of Complex Variables, 2ed by By Murray Spiegel, Seymour Lipschutz, John Schiller, Dennis Spellman.	

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
CMS301.1	2	3	2	3	-	1	-	-	-	-	3	2	2	-
CMS301.2	2	3	2	3	-	1	-	-	-	-	2	2	2	-
CMS301.3	2	3	2	3	-	1	-	-	-	-	2	2	2	-
CMS301.4	2	3	2	3	-	1	-	-	-	-	2	2	2	-
CMS301.5	2	3	2	3	-	1	-	-	-	-	3	2	2	-
CMS301.6	2	3	2	3	-	1	-	-	-	-	3	2	2	-
Average	**2.0**	**3.0**	**2.0**	**3.0**	**-**	**1.0**	**-**	**-**	**-**	**-**	**2.5**	**2.0**	**2.0**	**-**

School: SSBSR		**Batch: 2023-27**	
Programme: B.Sc. (Hons.)		**Academic Year: 2025-26**	
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 applications	CO4
	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%; ESE:75%	
	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	-	-	-	-	-	1	1	3
CMS302.2	3	3	3	3	-	1	-	-	-	-	-	1	1	3
CMS302.3	3	3	3	3	-	1	-	-	-	-	-	1	1	3
CMS302.4	3	3	3	3	-	1	-	-	-	-	-	1	1	3
CMS302.5	3	3	3	3	-	1	-	-	-	-	-	1	1	3
CMS302.6	3	3	3	3	-	1	-	-	-	-	-	1	1	3
Average	**3.0**	**3.0**	**3.0**	**3.0**	**-**	**1.0**	**-**	**-**	**-**	**-**	**-**	**1.0**	**1.0**	**3.0**

School: SSBSR		**Batch: 2023-27**	
Programme: B.Sc. (Hons.)		**Academic Year: 2025-26**	
Branch: Mathematics		**Semester: V**	
1	Course Code	**CMS303**	
2	Course Title	**Discrete Mathematics**	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
	Course Status	CC	
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,	CO1, CO2

		calculus,	
	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, Isomorphic ordered set, Well ordered set, Lattices, Properties of lattices, Bounded lattices, Distributive lattices, and Complemented lattices. Chains, and Anti-chains.	CO3
	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%; ESE:75%	
	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
CMS303.1	-	3	2	2	-	1	-	-	-	-	1	3	3	-
CMS303.2	-	3	2	2	-	1	-	-	-	-	1	3	3	-
CMS303.3	-	2	2	2	-	1	-	-	-	-	1	3	3	-
CMS303.4	-	3	2	2	-	1	-	-	-	-	1	3	3	-
CMS303.5	-	2	2	2	-	1	-	-	-	-	1	3	3	-
CMS303.6	-	2	2	2	-	1	-	-	-	-	1	3	3	-
Average	**-**	**2.5**	**2.0**	**2.0**	**-**	**1.0**	**-**	**-**	**-**	**-**	**1.0**	**3.0**	**3.0**	**-**

School: SSBSR		**Batch: 2023-27**	
Programme: B.Sc. (Hons.)		**Academic Year: 2025-26**	
Branch: Mathematics		**Semester: V**	
1	Course Code	**RBL003**	
2	Course Title	**Research Based Learning-3**	
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. Develop communication skills, especially in project writing and oral presentation. Develop some time management skills.	
6	Course Outcomes	CO1: Explain the concept of research within the subject, as regards approaching a question, collecting and 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, K6) CO4: Develop effective project organizational skills. (K5) CO5: Analyse the problem and summarize research findings. (K4,K5) CO6: Use 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**	**CO1**
	Unit 2	**Case study**	**CO1,CO2**
	Unit 3	**Conceptual**	**CO3, CO4**
	Unit 4	**Development**	**CO4, CO5**
	Unit 5	**Finalisation**	**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
RBL003.1	-	2	1	2	-	1	-	3	-	-	-	-	1	1
RBL003.2	-	2	1	2	-	1	-	3	-	-	-	-	1	1
RBL003.3	-	2	1	2	-	1	-	3	-	-	-	-	1	1
RBL003.4	-	2	1	2	-	1	-	3	-	-	-	-	1	1
RBL003.5	-	2	1	2	-	1	-	3	-	-	-	-	1	1
RBL003.6	-	2	1	2	-	1	-	3	-	-	-	-	1	1
Average	**-**	**2.0**	**1.0**	**2.0**	**-**	**1.0**	**-**	**3.0**	**-**	**-**	**-**	**-**	**1.0**	**1.0**

School: SSBSR		**Batch: 2023-27**	
Programme: B.Sc. (Hons.)		**Academic Year: 2025-26**	
Branch: Mathematics		**Semester: V**	
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	CO2,CO6,

		requirement, if any.	
	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	-	1	-	3	-	-	-	1	-	1
INC001.2	-	2	1	2	-	1	-	3	-	-	-	1	-	1
INC001.3	-	2	1	2	-	1	-	3	-	-	-	1	-	1
INC001.4	-	2	1	2	-	1	-	3	-	-	-	1	-	1
INC001.5	-	2	1	2	-	1	-	3	-	-	-	1	-	1
INC001.6	-	2	1	2	-	1	-	3	-	-	-	1	-	1
Average	**-**	**2.0**	**1.0**	**2.0**	**-**	**1.0**	**-**	**3.0**	**-**	**-**	**-**	**1.0**	**-**	**1.0**

School: SSBSR		**Batch: 2023-27**	
Programme: B.Sc. (Hons.)		**Academic Year: 2025-26**	
Branch: Mathematics		**Semester: V**	
1	Course Code	**CMS351**	
2	Course Title	**Mathematical Modelling Lab**	
3	Credits	1	
4	Contact Hours (L-T-P)	0-0-2	
	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:25%; CE:25%; ESE:50%	
	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**
CMS351.1	3	3	3	3	2	2	1	3	2	1	2	2	2	2
CMS351.2	3	3	3	3	2	2	1	3	2	1	2	2	2	2
CMS351.3	3	3	3	3	2	2	1	3	2	1	2	2	2	2
CMS351.4	3	3	3	3	2	2	1	3	2	1	2	2	2	2
CMS351.5	3	3	3	3	2	2	1	3	2	1	2	2	2	2
CMS351.6	3	3	3	3	2	2	1	3	2	1	2	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**	**2.0**

School: SSBSR		**Batch: 2023-27**	
Programme: B.Sc. (Hons.)		**Academic Year: 2025-26**	
Branch: Mathematics		**Semester: VI**	
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	CO2

		false position	
	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%; ESE:75%	
	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	2	2	-
CMS331.2	3	3	3	3	2	1	-	-	-	-	2	2	2	-
CMS331.3	3	3	3	3	2	1	-	-	-	-	2	2	2	-
CMS331.4	3	3	3	3	2	1	-	-	-	-	2	2	2	-
CMS331.5	3	3	3	3	2	1	-	-	-	-	2	2	2	-
CMS331.6	3	3	3	3	2	1	-	-	-	-	2	2	2	-
Average	**3.0**	**3.0**	**3.0**	**3.0**	**2.0**	**1.0**	**-**	**-**	**-**	**-**	**2.0**	**2.0**	**2.0**	**-**

School: SSBSR		Batch: 2023-27	
Programme: B.Sc. (Hons.)		**Academic Year: 2025-26**	
Branch:Mathematics		**Semester: VI**	
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	CO1

		elimination of arbitrary constants	
	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%; ESE:75%	
	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	-	-	-	-	-	2	2	-
CMS332.2	2	2	2	2	-	1	-	-	-	-	-	2	2	-
CMS332.3	3	3	3	3	-	1	-	-	-	-	-	2	2	-
CMS332.4	2	2	2	3	-	1	-	-	-	-	-	2	2	-
CMS332.5	2	3	3	3	-	1	-	-	-	-	-	2	2	-
CMS332.6	3	2	3	3	-	1	-	-	-	-	-	2	2	-
Average	**2.5**	**2.5**	**2.5**	**2.6**	**-**	**1.0**	**-**	**-**	**-**	**-**	**-**	**2.0**	**2.0**	**-**

School: SSBSR		**Batch: 2023-27**	
Programme: B.Sc. (Hons.)		**Academic Year: 2025-2026**	
Branch:Mathematics		**Semester: VI**	
1	Course Code	**CMS333**	
2	Course Title	**Graph Theory**	
3	Credits	3	
4	Contact Hours (L-T-P)	3-0-0	
	Course Status	CC	
5	Course Objective	The objective of the course is to explain basic concepts in combinatorial graph theory. Define how graphs serve as models for many standard problems. Discuss the concept of graph, tree, Euler graph, cut set and Combinatorics. See the applications of graphs in science, business and industry.	
6	Course Outcomes	CO1: Demonstrate knowledge of the syllabus material. (K2) CO2: Write precise and accurate mathematical definitions of objects in graph theory. (K6) CO3: Use mathematical definitions to identify and construct examples and to distinguish examples from non-examples.(K3, K6) CO4: Use a combination of theoretical knowledge and independent mathematical thinking in creative investigation of questions in graph theory. (K3, K6) CO5: Understand the application in engineering, biology, chemistry, physics. (K2) CO6: Write about graph theory in a coherent and technically accurate manner. (K6)	
7	Course Description	This course will cover the fundamental concepts of Graph Theory: simple graphs, digraphs, Eulerian and Hamiltonian graphs, trees, matchings, networks, paths and cycles, graph colorings, and planar graphs. Famous problems in Graph Theory include: Minimum Connector Problem (building roads at minimum cost), the Marriage Problem (matching men and women into compatible pairs), the Assignment Problem (filling n jobs in the best way), the Network Flow Problem (maximizing flow in a network), the Committee Scheduling Problem (using the fewest time slots), the Four Color Problem (coloring maps with four colors so that adjacent regions have different colors), and the Traveling Salesman Problem (visiting n cities with minimum cost).	
8	**Outline syllabus**		**CO Mapping**
	Unit 1	**Introduction to Graph Theory**	
	A	Graph, Subgraph, Various examples of graph and their subgraphs, Walks, Path and circuits, Connected graphs, Disconnected graphs and components.	CO1, CO2, CO3
	B	Euler’s graphs, various operation on graphs	CO1, CO2, CO3
	C	Hamiltonian Paths and circuits, Traveling salesman problem	CO1, CO2, CO3
	Unit 2	**Trees and its properties**	
	A	Trees and fundamental circuits, distance, diameters, radius and pendant vertices, rooted and binary trees, counting tree	CO1, CO2, CO4

	B	Spanning tree, Fundamental circuits, Finding all spanning trees of a graph	CO1, CO2, CO4
	C	Weighted graph, algorithm of prism's, Kruskal's and Dijikistrra's algorithm.	CO1, CO2, CO4
	Unit 3	**Cut-set & Cut-Vertices**	
	A	Cut-sets and cut-vertex , some properties, all cut-sets in a graph, Fundamental circuits and cut-sets, connectivity and separability	CO1, CO2, CO5
	B	Network flows, Planar graph, Combinatorial and geometric dual	CO1, CO2, CO5
	C	Kuratowaski's graphs, Detection of planetary, Geometric dual, Some more criterion of planarity, Thickness and crossing	CO1, CO2, CO5
	Unit 4	**Vector Space of Graphs**	
	A	Vector space of graphs and vectors, bases vector, cut-set vector, circuit vector, circuit and cut-set verses sub-spaces, orthogonal vector and subspaces	CO1, CO2, CO3, CO5
	B	Incidence matrix of graph, Sub matrix of A (G)	CO1, CO2, CO3, CO5
	C	Circuit matrix , Cut set matrix, Path matrix and relationship.	CO1, CO2, CO3,CO5
	Unit 5	**Coloring and Covering of Graphs**	
	A	Coloring and covering and partitioning of a graph, Chromatic number, chromatic partitioning, Chromatic polynomials, matching, Covering, 4-color problem	CO5, CO6
	B	Directed graphs, Some types of directed graphs, Directed Path and Connectedness, Euler's digraph, tree with directed edges, Fundamental circuits in digraphs, matrices A, B and C of digraphs adjacency matrices of a Digraph	CO5, CO6
	C	Enumeration, Types of enumeration, Counting of labelled and unlabelled trees, Statement of Poly's theorem.	CO5, CO6
	Mode of examination	Theory	
	Weightage Distribution	CA:25%; ESE:75%	
	Text book/s*	1. Deo. N., Graph Theory, PHI	
	Other References	1. Harary. F, Graph Theory, Narosa Publication.	

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
CMS333.1	3	3	2	2	-	1	-	-	-	-	2	2	2	-
CMS333.2	3	3	2	2	-	1	-	-	-	-	2	2	2	-
CMS333.3	3	3	3	3	-	1	-	-	-	-	2	2	2	-
CMS333.4	3	3	2	3	-	1	-	-	-	-	2	2	2	-
CMS333.5	3	3	3	3	-	1	-	-	-	-	2	2	2	-
CMS333.6	3	3	3	3	-	1	-	-	-	-	2	2	2	-
Average	**3.0**	**3.0**	**2.5**	**2.6**	**-**	**1.0**	**-**	**-**	**-**	**-**	**2.0**	**2.0**	**2.0**	**-**

School: SSBSR		**Batch: 2023-27**	
Programme: B.Sc. (Hons.)		**Academic Year: 2025-26**	
Branch: Mathematics		**Semester: VI**	
1	Course Code	**BDA323**	
2	Course Title	**Multivariate Data Analysis**	
3	Credits	3	
4	Contact Hours (L-T-P)	3-0-0	
	Course Status	CC	
5	Course Objective	Familiarise students with the multivariate normal distribution, estimation of the mean vector and the covariance matrix, the distributions and uses of sample correlation coefficients, classification of observations, the distribution of the sample covariance matrix, and the sample generalized variance.	
6	Course Outcomes	CO1: Demonstrate knowledge and understanding of the multivariate normal distribution. (K2, K3) CO2: Demonstrate knowledge and understanding of the concept of estimation of the mean vector and the covariance matrix. (K2, K3) CO3: Demonstrate advanced understanding of the concepts of dimension reduction technique. (K2, K3) CO4: Describe the concepts of how to use and apply dependence techniques in multivariate data analysis. (K2, K3) CO5: Describe the concepts of analysis of variance and covariance in multivariate data analysis. (K3, K4, K5) CO6: Apply the statistical tool and software in multivariate data analysis. (K2, K6)	
7	Course Description	This module aims to provide an understanding of the multivariate normal distribution, estimation of the mean vector and the covariance matrix, the distributions and uses of sample correlation coefficients, classification of observations, the distribution of the sample covariance matrix, and the sample generalized variance.	
8			
	Unit 1		
	A	A brief review of Univariate and Bivariate distribution with their properties.	CO1
	B	Basic Multivariate Distribution: mean, variance, Covariance, correlation, and the linear combination of variables.	CO1
	C	The multivariate normal distribution, Mean Vectors, and Covariance Matrices.	CO1

	Unit 2		
	A	Multivariate normal distribution; maximum likelihood estimation, Wishart's distribution	CO2
	B	Hotelling's T2 and hypothesis testing for multivariate normal data. Inference from a single sample, Inference from two dependent samples Inference from two independent samples.	CO2
	C	Simple, Multiple, Partial, and Canonical correlations with their properties.	CO2
	Unit 3		
	A	Principal Components Analysis and derivation of principal components: PCA structural model; PCA on normal populations; bi-plots.	CO3
	B	Factor Analysis, Factor extraction Factor rotation, Factor scores Validation of factor analysis, Higher order factor analysis Q-type factor analysis	CO3, CO4
	C	Cluster Analysis, Types of clustering, Correlation, and distance, Partitioning methods, hierarchical clustering, K-means clustering, and their interpretation.	CO4
	Unit 4		
	A	Simple, Multiple, and Multivariate regression with their properties.	CO5
	B	Binary and multidimensional Logistic regression.	CO5
	C	Linear discriminant function analysis. Estimating linear discriminant functions and their properties.	CO5
	Unit 5		
	A	Analysis of variance and covariance.	CO6
	B	Multivariate analysis of variance and Covariance.	CO6
	C	Concepts of correspondence analysis. chi-square distance and inertia, multiple correspondence analysis.	CO6
	Mode of examination	Theory	
	Weightage Distribution	CA:25%; ESE:75%	
	Text book/s*	1. Johnson, R.A. and Wichern, D.W.: (2015). Applied Multivariate Statistical Analysis, Sixth Edition, Pearson Education India.	
	Other References	1. Anderson, T.W. (2003): An Introduction to Multivariate Statistical Analysis, Third Edition, Wiley.	

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
BDA323.1	3	3	2	2	-	1	-	-	-	-	2	-	1	-
BDA323.2	2	3	3	2	-	1	-	-	-	-	2	-	1	-
BDA323.3	2	2	2	3	-	1	-	-	-	-	2	-	1	-
BDA323.4	2	3	2	2	-	1	-	-	-	-	2	-	1	-
BDA323.5	3	3	2	2	-	1	-	-	-	-	2	-	1	-
BDA323.6	3	3	2	3	-	1	-	-	-	-	2	-	1	-
Average	**2.3**	**2.6**	**2.0**	**2.1**	**-**	**1.0**	**-**	**-**	**-**	**-**	**2.0**	**-**	**1.0**	**-**

School: SSBSR		**Batch: 2023-27**	
Programme: B.Sc. (Hons.)		**Academic Year: 2025-26**	
Branch: Mathematics		**Semester: VI**	
1	Course Code	**RBL004**	
2	Course Title	**Research Based Learning-4**	
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. Develop communication skills, especially in project writing and oral presentation. Develop some time management skills.	
6	Course Outcomes	CO1: Explain the concept of research within the subject, as regards approaching a question, collecting and 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, K6) CO4: Develop effective project organizational skills. (K5) CO5: Analyse the problem and summarize research findings. (K4,K5) CO6: Use 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**	**CO1**
	Unit 2	**Case study**	**CO1,CO2**
	Unit 3	**Conceptual**	**CO3,CO4**
	Unit 4	**Development**	**CO4, CO5**
	Unit 5	**Finalisation**	**CO5, CO6**
	Mode of examination		
	Weightage		

	Distribution		
	Text book/s*		
	Other References		

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO	**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**
CO														
RBL004.1	-	2	1	2	-	1	-	3	-	-	-	1	1	1
RBL004.2	-	2	1	2	-	1	-	3	-	-	-	1	1	1
RBL004.3	-	2	1	2	-	1	-	3	-	-	-	1	1	1
RBL004.4	-	2	1	2	-	1	-	3	-	-	-	1	1	1
RBL004.5	-	2	1	2	-	1	-	3	-	-	-	1	1	1
RBL004.6	-	2	1	2	-	1	-	3	-	-	-	1	1	1
Average	**-**	**2.0**	**1.0**	**2.0**	**-**	**1.0**	**-**	**3.0**	**-**	**-**	**-**	**1.0**	**1.0**	**1.0**

<table>
<tr><td colspan="2">School: SSBSR</td><td>Batch: 2023-27</td></tr>
<tr><td colspan="2">Program: B.Sc. (Research)</td><td>Academic Year: 2025-26</td></tr>
<tr><td colspan="2">Branch: Mathematics</td><td>Semester: VI</td></tr>
<tr><td>1</td><td>Course Number</td><td>Course Code: CCU108</td></tr>
<tr><td>2</td><td>Course Title</td><td>Community Connect</td></tr>
<tr><td>3</td><td>Credits</td><td>2 Course Status: Training/Survey/Project</td></tr>
<tr><td>4</td><td>(L-T-P)</td><td>(0-0-4)</td></tr>
<tr><td>5</td><td>Learning Hours</td><td><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>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>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.</td></tr>
</table>

		CO6: The survey will help to identify the gaps and create a plan to further improve the situation related to social problems prevailing in different sections of society and 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	**Guidelines for Faculty Members**	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**. ETE will conduct out of 100, divided in three parts (i) 30 Marks for the report (ii) 30 Marks for the presentation (iii) 40 Marks for knowledge. The student should **submit the report** to CCC-Coordinator signed by the faculty guide by ………………… The students have to send the hard copy of the **report and PPT**, and then only they will be allowed for ETE.
9.2	**Role of CCC-Coordinator**	The CCC Coordinator will supervise the whole process and assign students to faculty members. 1. UG- B.Sc.-Semester VI - the students will be allocated to faculty member (mentors/faculty member) in odd term.
9.3	**Layout of the Report**	Abstract (250 words) a. Introduction b. Literature review(optional) c. Objective of the research d. Research Methodology e. Finding and discussion f. Conclusion and recommendation g. References Note: Research report should base on primary data.
9.4	**Guideline for Report Writing**	**Title Page: The following elements must be included:** • Title of the article; • Name(s) and initial(s) of author(s), preferably with first names spelled out; • Affiliation(s) of author(s); • Name of the faculty guide and Co-guide **Abstract:** Each article is to be preceded by a succinct abstract, of up to 250 words, that highlights the objectives, methods, results, and conclusions of the paper. **Text: Manuscripts should be submitted in Word.** • Use a normal, plain font (e.g., 12-point Times Roman) for text. • Use italics for emphasis. • *Use the automatic page numbering function to number the pages.* • *Save your file in docx format* (Word 2007 or higher) or doc format (older Word versions) **Reference list:**

		The list of references should only include works that are cited in the text and that have been published or accepted for publication. The entries in the list should be in alphabetical order. Journal article Hamburger, C.: Quasimonotonicity, regularity and duality for nonlinear systems of partial differential equations. Ann. Mat. Pura Appl. 169, 321–354 (1995) Article by DOI Sajti, C.L., Georgio, S., Khodorkovsky, V., Marine, W.: New nanohybrid materials for biophotonics. Appl. Phys. A (2007). doi:10.1007/s00339-007-4137-z Book Geddes, K.O., Czapor, S.R., Labahn, G.: Algorithms for Computer Algebra. Kluwer, Boston (1992) Book chapter Broy, M.: Software engineering — from auxiliary to key technologies. In: Broy, M., Denert, E. (eds.) Software Pioneers, pp. 10–13. Springer, Heidelberg (2002) Online document Cartwright, J.: Big stars have weather too. IOP Publishing PhysicsWeb. http://physicsweb.org/articles/news/11/6/16/1 (2007). Accessed 26 June 2007 Always use the standard abbreviation of a journal's name according to the ISSN List of Title Word Abbreviations, see www.issn.org/2-22661-LTWA-online.php For authors using EndNote, Springer provides an output style that supports the formatting of in-text citations and reference list. EndNote style (zip, 2 kB) **Tables: All tables are to be numbered using Arabic numerals.** **Figure Numbering: All figures are to be numbered using Arabic numerals**.
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	2	2	3	3	3	2	1	2	2	3
CCU108.2	1	2	2	3	2	2	3	3	3	2	1	2	2	3
CCU108.3	1	2	2	3	2	2	3	3	3	2	1	2	2	3
CCU108.4	1	2	2	3	2	2	3	3	3	2	1	2	2	3
CCU108.5	1	2	2	3	2	2	3	3	3	2	1	2	2	3
CCU108.6	1	2	2	3	2	2	3	3	3	2	1	2	2	3
Average	**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**

School: SSBSR		**Batch: 2023-27**	
Programme: B.Sc. (Hons.)		**Academic Year: 2025-26**	
Branch: Mathematics		**Semester: VI**	
1	Course Code	**CMS371**	
2	Course Title	**Numerical Methods Lab**	
3	Credits	1	
4	Contact Hours (L-T-P)	0-0-2	
	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. 3. To provide the students are able to formulate a real-world problem as a mathematical programming model, understand the theoretical workings of the simplex method for linear programming and perform iterations of it by hand, relationship between a linear program and its dual, including strong duality and complementary slackness and solve specialized linear programming problems like the transportation and assignment problems.	
6	Course Outcomes	CO1: Understand the procedures, algorithms, and concepts require to solve specific problems. CO2: Discuss and develop the algorithms to solve system of linear equations and measure the accuracy. CO3: Discuss and develop the algorithms to solve finite differences and interpolation and measure the accuracy. CO4: Discuss and develop the algorithms to solve system of transcendental equations and measure the accuracy. CO5: Discuss and develop the algorithms to solve divided differences and measure the accuracy. CO6: Discuss and develop the algorithms to solve numerical differentiation and integration and measure the accuracy.	
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 transcendental and algebraic equations**	
	A, B, C	i) Bisection method ii) Newton Raphson method (Simple root, multiple roots, complex roots). iii) Secant method. iv) Regula Falsi method.	**CO1**
	Unit 2	**Solution of system of linear equations**	
	A, B, C	i) LU decomposition method ii) Gaussian elimination method iii) Gauss-Jacobi method Gauss-Seidel method	**CO1,CO2**
	Unit 3	**Interpolation**	
	A, B, C	i) Lagrange Interpolation Newton's forward, backward and divided difference interpolations	**CO2,CO3**
	Unit 4	**Numerical Integration**	

	A, B, C	i) Trapezoidal Rule ii) Simpson's one third rule iii) Weddle's Rule iv) Gauss Quadrature (iv) The method of successive approximations (Picard)	**CO3, CO4**
	Unit 5	**Solution of ODE**	
	A, B, C	Method of finding Eigenvalue by Power method (up to 4 × 4) Fitting a Polynomial Function (up to third degree) Solution of ordinary differential equations i) Euler method ii) Modified Euler method Runge Kutta method (order 4)	**CO5,CO6**
	Mode of examination	Practical	
	Weightage Distribution	CA:25%; CE:25%; ESE:50%	
	Text book/s*	1.Applied Numerical Methods Using Matlab, Tae-Sang Chung, Wŏn-yŏng Yang, John Morris, Wenwu Cao, Wiley-India.	
	Other References	1. MATLAB Programming for Numerical Analysis, César Pérez López, Apress.	

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**
CMS371.1	3	3	3	2	2	1	2	3	1	1	3	2	2	2
CMS371.2	3	3	3	2	2	1	2	3	1	1	3	2	2	2
CMS371.3	3	3	3	2	2	1	2	3	1	1	3	2	2	2
CMS371.4	3	3	3	2	2	1	2	3	1	1	3	2	2	2
CMS371.5	3	3	3	2	2	1	2	3	1	1	3	2	2	2
CMS371.6	3	3	3	2	2	1	2	3	1	1	3	2	2	2
Average	**3.0**	**3.0**	**3.0**	**2.0**	**2.0**	**1.0**	**2.0**	**3.0**	**1.0**	**1.0**	**3.0**	**2.0**	**2.0**	**2.0**

School: SSBSR		**Batch: 2023-27**	
Programme: B.Sc. (Hons.)		**Academic Year: 2025-26**	
Branch: Mathematics		**Semester: VI**	
1	Course Code	**CMS372**	
2	Course Title	**Introduction to Partial Differential Equations Lab**	
3	Credits	1	
4	Contact Hours (L-T-P)	0-0-2	
	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	11.)Solution of first order Partial Differential Equations 12.) Lagrange's method to solve linear PDEs. .	CO 1

	Unit 2		
	A, B, C	13.)Linear homogeneous PDE with constant 14.)Particular integral for some specific cases.	CO 2
	Unit 3		
	A, B, C	15.)Linear non-homogeneous PDE with constant coefficient. 16.)finding complementary function.	CO 3
	Unit 4		
	A, B, C	17.)Classification of PDEs of second order, 18.)method of separation of variables 19.)D'Alembert's solution of wave equation	CO 4
	Unit 5		
	A, B, C	20.) Solution of heat equation in one dimension, 21.)Solution of Laplace equation in Cartesian coordinates	CO 5, CO 6
	Mode of examination	Practical + viva	
	Weightage Distribution	CA:25%; CE:25%; ESE:50%	
	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**
CMS372.1	3	3	3	3	2	1	2	3	2	2	3	2	2	2
CMS372.2	3	3	3	3	2	1	2	3	2	2	3	2	2	2
CMS372.3	3	3	3	3	2	1	2	3	2	2	3	2	2	2
CMS372.4	3	3	3	3	2	1	2	3	3	2	3	2	2	2
CMS372.5	3	3	3	3	2	1	2	3	2	2	3	2	2	2
CMS372.6	3	3	3	3	2	1	2	3	3	2	3	2	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**	**2.0**

School: SSBSR		**Batch: 2023-27**	
Programme: B.Sc. (Hons.)		**Academic Year: 2025-26**	
Branch: Mathematics		**Semester: VI**	
1	Course Code	**BDA361**	
2	Course Title	**Multivariate Data Analysis Lab**	
3	Credits	1	
4	Contact Hours(L-T-P)	0-0-2	
	Course Status	CC	
5	Course Objective	Familiarise students with the multivariate normal distribution, estimation of the mean vector and the covariance matrix, the distributions and uses of sample correlation coefficients, classification of observations, the distribution of the sample covariance matrix, and the sample generalized variance.	
6	Course Outcomes	CO1: Demonstrate knowledge and understanding of the multivariate normal distribution. (K2, K3) CO2: Demonstrate knowledge and understanding of the concept of estimation of the mean vector and the covariance matrix. (K2, K3) CO3: Demonstrate advanced understanding of the concepts of dimension reduction technique. (K2, K3) CO4: Describe the concepts of how to use and apply dependence techniques in multivariate data analysis. (K2, K3) CO5: Describe the concepts of analysis of variance and covariance in multivariate data analysis. (K3, K4, K5) CO6: Apply the statistical tool and software in multivariate data analysis. (K2, K6)	
7	Course Description	This module aims to provide an understanding of the multivariate normal distribution, estimation of the mean vector and the covariance matrix, the distributions and uses of sample correlation coefficients, classification of observations, the distribution of the sample covariance matrix, and the sample generalized variance.	
8	**Outline syllabus**		**CO Mapping**
	Unit 1		
	A, B, C	Problem based on Data Cleaning and Data Screening	CO1, CO2
		Problem based on to check Data Normality	
		Problem based on to check Reliability Testing	
	Unit 2		

	A, B, C	Problem based on Multiple and Partial correlation	CO2, CO3
		Problem based on Canonical correlation	
	Unit 3		
	A, B, C	Problem based on Principal Component Analysis	CO3, CO4
		Problem based on Factor Analysis: Exploratory factor analysis	
		Problem based on Cluster Analysis: Hierarchal Cluster and Non-hierarchal Cluster	
	Unit 4		
	A, B, C	Problem based on Multiple regression analysis	CO4, CO5, CO6
		Problem based on Logistic regression analysis	
		Problem based on Discriminant Analysis	
	Unit 5		
	A, B, C	Problem based on Analysis of Variance	CO5, CO6
		Problem based on Analysis of and Covariance	
		Problem based on Multivariate Analysis of Variance and Covariance	
	Mode of examination	Practical+Viva	
	Weightage Distribution	CA:25%; CE:25%; ESE:50%	
	Text book/s*	1. Hardle, W.K. and Hlavka, Z. (2015): Multivariate Statistics, Springer.	
	Other References	1.Anderson, T.W. (2003): An Introduction to Multivariate Statistical Analysis, Third Edition, Wiley.	

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
BDA361.1	1	2	3	2	2	1	1	3	1	-	2	-	1	2
BDA361.2	1	2	3	2	2	1	1	3	1	-	2	-	1	2
BDA361.3	1	2	3	2	2	1	1	3	1	-	2	-	1	2
BDA361.4	1	2	3	2	2	1	1	3	1	-	2	-	1	2
BDA361.5	1	2	3	2	2	1	1	3	1	-	2	-	1	2
BDA361.6	1	2	3	2	2	1	1	3	1	-	2	-	1	2
Average	**1.0**	**2.0**	**3.0**	**2.0**	**2.0**	**1.0**	**1.0**	**3.0**	**1.0**	**-**	**2.0**	**-**	**1.0**	**2.0**

Detailed Syllabus for

HONOURS

OR

HONOURS WITH RESEARCH

IN

MATHEMATICS

School: SSBSR		**Batch: 2023-27**	
Programme: B.Sc. (Hons.)		**Academic Year: 2026-27**	
Branch: Mathematics		**Semester: VII**	
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	**CC**	
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%; ESE:75%	
	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	-	-	-	2	3	3	2	-
CMS401.2	3	3	3	3	2	1	-	-	-	2	3	3	2	-
CMS401.3	3	3	3	3	2	1	-	-	-	2	3	3	2	-
CMS401.4	3	3	3	3	2	1	-	-	-	2	3	3	2	-
CMS401.5	3	3	3	3	2	1	-	-	-	2	3	3	2	-
CMS401.6	3	3	3	3	2	1	-	-	-	2	3	3	2	-
Average	**3.0**	**3.0**	**3.0**	**3.0**	**2.0**	**1.0**	**-**	**-**	**-**	**2.0**	**3.0**	**3.0**	**2.0**	**-**

School: SSBSR		**Batch: 2023-27**	
Programme: B.Sc. (Hons.)		**Academic Year: 2026-2027**	
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%; ESE:75%	
	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	PS 11	PSO 1	PSO 2	PSO 3
CMS403.1	3	3	2	2	-	2	-	-	-	-	-	-	3	-
CMS403.2	2	3	2	2	-	2	-	-	-	-	-	-	3	-
CMS403.3	2	2	2	2	-	2	-	-	-	-	-	-	3	-
CMS403.4	2	3	2	2	-	2	-	-	-	-	-	-	3	-
CMS403.5	3	2	2	2	-	2	-	-	-	-	-	-	3	-
CMS403.6	3	2	2	2	-	2	-	-	-	-	-	-	3	-
Average	**2.5**	**2.5**	**2.0**	**2.0**	**-**	**2.0**	**-**	**-**	**-**	**-**	**-**	**-**	**3.0**	**-**

School: SSBSR		**Batch: 2023-27**	
Programme: B.Sc. (Hons.)		**Academic Year: 2026-27**	
Branch: Mathematics		**Semester: VII**	
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	**CC**	
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 Commonly Used FD Methods for Linear System of Hyperbolic PDEs	CO5, CO6
	Mode of examination	Lab	

	Weightage Distribution	CA: 25%; CE:25%; ETE:50%	
	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	1	3	3	3	3
CMS451.2	3	3	3	3	3	1	3	3	1	1	3	3	3	3
CMS451.3	3	3	3	3	3	1	3	3	1	1	3	3	3	3
CMS451.4	3	3	3	3	3	1	3	3	1	1	3	3	3	3
CMS451.5	3	3	3	3	3	1	3	3	1	1	3	3	3	3
Average	**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**

School: SSBSR		**Batch: 2023-27**	
Programme: B.Sc. (Hons.)		**Academic Year: 2026-27**	
Branch: Mathematics		**Semester: VIII**	
1	Course Code	**CMS431**	
2	Course Title	**Finite Element Methods**	
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 Mathematical Modelling of real-world problems. 2.To appreciate the use of FEM to a range of Engineering Problems.	
6	Course Outcomes	CO1: Summarize the basics of finite element formulation. CO2: Apply finite element formulations to solve one dimensional Problems. CO3: Apply finite element formulations to solve two-dimensional scalar Problems. CO4: Apply finite element method to solve two-dimensional Vector problems. CO5: Apply finite element method to solve problems on iso parametric element and dynamic Problems. CO6: Recognize the need for, and engage in life long learning	
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	**INTRODUCTION**	
	A	Historical Background – Mathematical Modeling of field problems in Engineering – Governing Equations.	CO1
	B	Discrete and continuous models – Boundary, Initial and Eigen Value problems– Weighted Residual Methods	CO1
	C	Variational Formulation of Boundary Value Problems – Ritz Technique – Basic concepts of the Finite Element Method.	CO1
	Unit 2	**ONE-DIMENSIONAL PROBLEMS**	
	A	One Dimensional Second Order Equations – Discretization – Element types- Linear and Higher order Elements.	CO2
	B	Derivation of Shape functions and Stiffness matrices and force vectors- Assembly of Matrices - Solution of problems from solid	CO2

		mechanics and heat transfer.	
	C	Longitudinal vibration frequencies and mode shapes. Fourth Order Beam Equation –Transverse deflections and Natural frequencies of beams.	CO2
	Unit 3	**TWO-DIMENSIONAL SCALAR VARIABLE PROBLEMS**	
	A	Second Order 2D Equations involving Scalar Variable Functions – Variational formulation –Finite Element formulation – Triangular elements – Shape functions and element matrices and vectors.	CO3
	B	Application to Field Problems - Thermal problems – Torsion of Non circular shafts.	CO3
	C	Quadrilateral elements – Higher Order Elements.	CO3
	Unit 4	**TWO-DIMENSIONAL VECTOR VARIABLE PROBLEMS**	
	A	Equations of elasticity – Plane stress, plane strain.	CO4
	B	and axisymmetric problems – Body forces and temperature effects.	CO4
	C	Stress calculations - Plate and shell elements.	CO4
	Unit 5	**ISOPARAMETRIC FORMULATION**	
	A	Natural co-ordinate systems – Isoparametric elements – Shape functions for iso parametric elements – One and two dimensions.	CO5, CO6
	B	Serendipity elements – Numerical integration and application to plane stress problems - Matrix solution techniques.	CO5, CO6
	C	Solutions Techniques to Dynamic problems – Introduction to Analysis Software.	CO5, CO6
	Mode of examination	Theory	
	Weightage Distribution	CA:25%; ESE:75%	
	Text book/s*	1. Reddy. J.N., “An Introduction to the Finite Element Method”, 3rd Edition, Tata McGraw-Hill, 2005	
	Other References	1. Logan, D.L., “A first course in Finite Element Method”, Thomson Asia Pvt. Ltd., 2002	

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**	**PSO 1**	**PSO 2**	**PSO 3**
CMS431.1	3	3	2	2	2	1	-	-	-	1	3	3	-
CMS431.2	3	3	2	2	2	1	-	-	-	1	3	3	-
CMS431.3	3	3	2	2	2	1	-	-	-	1	3	3	-
CMS431.4	3	3	2	2	2	1	-	-	-	1	3	3	-
CMS431.5	3	3	2	2	2	1	-	-	-	1	3	3	-
CMS431.6	3	3	2	2	2	1	-	-	-	1	3	3	-
Average	**3.0**	**3.0**	**2.0**	**2.0**	**2.0**	**1.0**	**-**	**-**	**-**	**1.0**	**3.0**	**3.0**	**-**

<table>
<tr><td>School: SSBSR</td><td colspan="2">Batch: 2023-27</td></tr>
<tr><td>Programme: B.Sc. (Hons.)</td><td colspan="2">Academic Year: 2026-27</td></tr>
<tr><td>Branch:Mathematics</td><td colspan="2">Semester: VIII</td></tr>
<tr><td>1</td><td>Course Code</td><td>CMS432</td></tr>
<tr><td>2</td><td>Course Title</td><td>Optimization Techniques</td></tr>
<tr><td>3</td><td>Credits</td><td>4</td></tr>
<tr><td>4</td><td>Contact Hours (L-T-P)</td><td>4-0-0</td></tr>
<tr><td></td><td>Course Status</td><td>CC</td></tr>
<tr><td>5</td><td>Course Objective</td><td>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.</td></tr>
<tr><td>6</td><td>Course Outcomes</td><td>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).</td></tr>
<tr><td>7</td><td>Course Description</td><td>This course is an introduction to the basic understanding of with applications and scope of O.R. Formulation of linear programming problem and then different methods to solve them will be discussed. Duality in LPP will be introduced. Introduction to NLPP and some solving methods will be covered. At the end KKT Conditions, Unconstrained and constrained optimization techniques will be discussed.</td></tr>
</table>

<table>
<tr><td>8</td><td colspan="2">Outline syllabus</td><td>CO Mapping</td></tr>
<tr><td></td><td>Unit 1</td><td>Introduction to LPP , Graphical Method and Simplex Method</td><td></td></tr>
<tr><td></td><td>A</td><td>Introduction to Optimization, Assumptions & Mathematical Modeling of LPP, Graphical solution of L.P.P., Graphical Solution of LPP-I, Graphical Solution of LPP- II.</td><td>CO1</td></tr>
<tr><td></td><td></td><td>Solution of L.P.P.by Simplex method, Revised Simplex Method, Introduction of Big M method, Algorithm of BIG-M method.</td><td>CO1</td></tr>
</table>

	B		
	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 Method**	
	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%; ESE:75%	

	Text book/s*	1. Hamdy A. Taha, Operations Research, An Introduction, 9th Edition, Pearson.	
	Other References	1. M.S. Bazarra, H.D. Sheral and C.M. Shetty, Nonlinear Programming theory and Algorithms.	

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**
CMS432.1	3	3	3	3	2	1	-	-	-	-	3	3	3	-
CMS432.2	3	3	3	3	2	1	-	-	-	-	3	3	3	-
CMS432.3	3	3	3	3	2	1	-	-	-	-	3	3	3	-
CMS432.4	3	3	3	3	2	1	-	-	-	-	3	3	3	-
CMS432.5	3	3	3	3	2	1	-	-	-	-	3	3	3	-
CMS432.6	3	3	3	3	2	1	-	-	-	-	3	3	3	-
Average	**3.0**	**3.0**	**3.0**	**3.0**	**2.0**	**1.0**	**-**	**-**	**-**	**-**	**3.0**	**3.0**	**3.0**	**-**

School: SSBSR		**Batch: 2023-27**	
Programme: B.Sc. (Hons.)		**Academic Year: 2026-27**	
Branch: Mathematics		**Semester: VIII**	
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	CC	
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,	CO1

		Relation between differential and integral equations.	
	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%; ESE:75%	

	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	2	2	-
CMS433.2	3	3	3	3	2	1	-	-	-	-	2	2	2	-
CMS433.3	3	3	3	3	2	1	-	-	-	-	2	2	2	-
CMS433.4	3	3	3	3	2	1	-	-	-	-	2	2	2	-
CMS433.5	3	3	3	3	2	1	-	-	-	-	2	2	2	-
CMS433.6	3	3	3	3	2	1	-	-	-	-	2	2	2	-
Average	**3.0**	**3.0**	**3.0**	**3.0**	**2.0**	**1.0**	**-**	**-**	**-**	**-**	**2.0**	**2.0**	**2.0**	**-**

School: SSBSR		**Batch: 2023-27**	
Programme: B.Sc. (Hons.)		**Academic Year: 2026-27**	
Branch: Mathematics		**Semester: VII**	
1	Course Code	**CMS402**	
2	Course Title	**Fluid Dynamics**	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
	Course Status	DSE	
5	Course Objective	To introduce the student to widely used techniques in the numerical solution of fluid equations, issues that arise in the solution of such equations, and modern trends in CFD. Emphasis will be on 'learning by doing', as students will work on programming projects for assignments.	
6	Course Outcomes	CO1: The course provides an introduction to computational fluid dynamics. CO2: The students will train the numerical solution of model problems by developing and testing own MATLAB programs. CO3: The students will learn to assess the quality of numerical results and the efficiency of numerical methods for basic fluid flow model problems. CO4: After completion of this course, the student will have knowledge on: Classification of the basic equations of fluid dynamics. CO5: After completion of this course, the student will have skills on: - Practical use and programming of numerical methods in fluid dynamics. CO6: After successful completion of this course, the student will have general competence on: Numerical solution of model problems in fluid dynamics. Checking and assessing basic numerical methods for fluid flow problems.	
7	Course Description	This course aims to introduce numerical modelling and its role in automotive field; it will enable the students to understand the various discretization methods and solving methodologies and to create confidence to solve complex problems in the automotive field with the knowledge of Heat transfer and fluid dynamics. Further students can able to develop finite difference and finite volume discretized forms of the CFD equations and to formulate explicit & implicit algorithms for solving the Euler Equations & Navier Stokes Equations.	
8	**Outline syllabus**		**CO Mapping**
	Unit 1		
	A	Introduction and Basic Concepts: Introduction of CFD, Types of fluids and basic equations of flow, Mass Conservation, Newton's second law of motion.	CO1
	B	Fluid flow governing equations, Navier– stokes equation, Boundary layer equations, Expanded form of Navier-stokes equations, Conservation of energy principle, Special form of energy equation.	CO1
	C	Classification of second order partial differential equations, Initial and Boundary conditions, Governing equations in generalized coordinates, Review of essentials of fluid dynamics.	CO2
	Unit 2		
	A	Elementary Finite Difference Equations, Basic aspects of finite difference equations, errors and stability analysis, discretization.	CO3
	B	Taylor's series expansion, difference equation: explicit and implicit. .	CO3
	C	Application to heat conduction and convection, problems on one dimension steady state and unsteady state conduction.	CO3
	Unit 3		
	A	Grid Transformation Introduction, general transformation equations.	CO4

	B	matrices and Jacobean, transformed version of governing equationparticularly suited for CFD.	CO4
	C	Compressed grids, elliptic grid generation, adaptive grids.	CO4
	Unit 4		
	A	Introduction to finite element philosophy, Basics of finite elementmethod.	CO5
	B	Stiffness matrix, Isoperimatric elements.	CO5
	C	Formulation of finite elements for flow and heat transfer problems.	CO5
	Unit 5		
	A	Introduction to finite volume philosophy Integral approach.	CO6
	B	Discretization and higher order schemes.	CO6
	C	Application to complex geometry.	CO6
	Mode of examination	Theory	
	Weightage Distribution	CA:25%; ESE:75%	
	Text book/s*	1. Computational Fluid Dynamics the Basics with Applications, John DAnderson, Jr., McGraw Hill Book Company.	
	Other References	1. Principles of Computational Fluid dynamics, Pieter Wesseling, Springer International Edition	

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**
CMS402.1	2	2	2	2	1	1	-	-	-	-	1	1	1	-
CMS402.2	2	2	2	2	1	1	-	-	-	-	1	1	1	-
CMS402.3	2	2	2	2	1	1	-	-	-	-	1	1	1	-
CMS402.4	2	2	2	2	1	1	-	-	-	-	1	1	1	-
CMS402.5	2	2	2	2	1	1	-	-	-	-	1	1	1	-
CMS402.6	2	2	2	2	1	1	-	-	-	-	1	1	1	-
Average	**2.0**	**2.0**	**2.0**	**2.0**	**1.0**	**1.0**	**-**	**-**	**-**	**-**	**1.0**	**1.0**	**1.0**	**-**

School: SSBSR		**Batch : 2023-27**	
Programme: B.Sc(Hons)		**Academic Year: 2026-27**	
Branch: Mathematics		**Semester: VII**	
1	Course Code	**MMT107**	
2	Course Title	**TOPOLOGY**	
3	Credits	4	
4	Contact Hours(L-T-P)	4-0-0	
	Course Status	DSE	
5	Course Objective	This course provides an introduction to topics involving concepts ofTopological space and separate axioms (Hausdorff space and base problems), Compactness (Urysohn's theorem), Connectedness WithNets(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, indiscreteand 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 andsecond countable)	CO2
	B	separation axioms: T_0,T_1,T_2 spaces, normal and completely normal spaces	CO2
	C	regular and completely regular spaces, T_3, T_4 and Tychnoff space, Hausdorff space and based problems	CO2

	Unit 3	**Compactness**	
	A	Cover, open cover, finite sub cover, compact sets, finite intersection property	CO3
	B	Heine borel theorem, Lindeloff space, locally compact, Map: continuous function	CO3, CO4
	C	homeomorphism, open and closed map, compactnessfor 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:25%; ESE:75%	
	Text book/s*	1. Dugundji, James, Topology, Allyn and BaconSeries 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.	

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO	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
CO														
MMT107.1	1	3	2	3	3	1	-	-	-	-	1	1	3	-
MMT107.2	1	3	2	3	3	1	-	-	-	-	1	1	3	-
MMT107.3	1	3	2	3	3	1	-	-	-	-	1	1	3	-
MMT107.4	1	3	2	3	3	1	-	-	-	-	1	1	3	-
MMT107.5	1	3	2	3	3	1	-	-	-	-	1	1	3	-
MMT107.6	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 : 2023-27**	
Programme: B.Sc(Hons.)		**Academic Year: 2026-27**	
Branch: Mathematics		**Semester: VII**	
1	Course Code	**MMT202**	
2	Course Title	**MEASURE THEORY**	
3	Credits	**4**	
4	Contact Hours (L-T-P)	**4-0-0**	
	Course Status	DSE	
5	Course Objective	This course provides an introduction to topics involving concepts of Topological space, □ -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 andwrite 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, □ -algebra of measurable sets,Borel sets, measurable functions, Lebesgue measure, integration of complex functions and linear functional. The primary objective of thecourse is to develop the advance understanding of Measure Theory.	
8	Outline syllabus		CO Mapping
	Unit 1	Preliminaries:	
	A	Topological spaces, continuous functions	CO1
	B	□ -algebra of measurable sets, Borel sets, measurable functions	CO1
	C	lim sup and lim inf of sequence of functions.	CO1

	Unit 2	Lebesgue measure:	
	A	Approximation of measurable functions by simple functions, positive measures	CO2
	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 setsof 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:25%; ESE:75%	
	Text book/s*	1) Walter Rudin: Real and Complex analysis, Mc GRAW HILL, International student edition.	
	Other References	1. H. L. Royden: Real Analysis, Amazon. Com.	

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**
MMT202.1	1	3	2	3	3	1	-	-	-	-	1	1	3	-
MMT202.2	1	3	2	3	3	1	-	-	-	-	1	1	3	-
MMT202.3	1	3	2	3	3	1	-	-	-	-	1	1	3	-
MMT202.4	1	3	2	3	3	1	-	-	-	-	1	1	3	-
MMT202.5	1	3	2	3	3	1	-	-	-	-	1	1	3	-
MMT202.6	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: 2023-26**	
Programme: B.Sc. (Hons.)		**Academic Year: 2026-27**	
Branch: Mathematics		**Semester: VII**	
1	Course Code	**CMS404**	
2	Course Title	**Introduction to Methods of Applied Mathematics**	
3	Credits	**4**	
4	Contact Hours (L-T-P)	**4-0-0**	
	Course Status	**DSE**	
5	Course Objective	To learn the fundamental concepts of differential and integral calculus, theory of ordinary differential equations and applications. Applications of partial differential equations. To learn basics of fourier Series and Fourier transforms.	
6	Course Outcomes	Students will be able to: CO1: Explain the concept of differential equations, illustrate the second order linear differential equations with constant coefficients, and use power series solution. (K2,K3, K4) CO2: Explain the concept of partial differential equation, describe method of separation of variables, and evaluate wave equation, heat equation and Laplace equation using method of separation of variables. . (K1, K2, K3, K4, K5) CO3: Describe Laplace transform and Inverse Laplace transform and evaluate Convolution theorem. (K1, K2, K3, K5). CO4: Describe Fourier Series, Fourier transform and Applications.(K2,K3,K5) CO5: Explain the concept of Fourier Integrals and transformation. CO6: Describe Integral Fourier transform is described as a specific wavelet-like transform with fully scalable modulated window, but not all possible translation. The transform is defined by sinusoidal waves of half periods.	
7	Course Description	This course is an introduction to the basic understanding of differential equations, partial differential equations, Fourier Series, Fourier transforms and Applications.	
8	**Outline syllabus**		**CO Mapping**
	Unit 1	**Ordinary Differential Equations**	

	A	Introduction to First Order Differential Equations, Introduction to Second Order Linear Differential Equations and Second Order Linear Differential Equations With Constant Coefficients.	CO1
	B	Solve the Second Order Linear Differential Equations With Variable Coefficients, Factorization of Second order Differential Operator & Euler Cauchy Equation and Power Series Solution of General Differential Equation.	CO1
	C	Find the solution of Euler Cauchy Equation and Power Series Solution of General Differential Equation.	CO1
	Unit 2	**Partial differential equations**	
	A	Definition, classification of partial differential equation, method of separation of variables.	CO2
	B	Solution of wave equation, Heat equation and Laplace equation using method of separation of variables.	CO2
	C	Explain Green's function, Method of Green's Function for Solving Initial Value & Boundary Value Problems.	CO2
	Unit 3	**Adjoint Linear Differential Equations and Laplace Transform**	
	A	Find the Adjoint Linear Differential Operator, Adjoint Linear , define Sturm-Liouvile Problems.	CO3
	B	Find the Laplace transformation and properties, Inverse Laplace Transform.	CO3
	C	Define the Laplace Transform Method for Solving Ordinary Differential Equations and Laplace Transform Applied to Differential Equations & Convolution.	CO3
	Unit 4	**Fourier Series and Fourier Transform**	
	A	Def. Fourier Series and Fourier Transform and solution of some problems and Gibbs Phenomenon and Parseval's Identity.	CO4
	B	Explain the Fourier Integral and Fourier Transform, Fourier Transform Method for Solving Ordinary Differential Equations.	CO4
	C	Find the Frames, Riesz Bases and Orthonormal Bases.	CO4
	Unit 5	**Fourier Series and Fourier Transform**	
	A	Define Fourier Series and Fourier Transform, Time-Frequency Analysis and Gabor Transform and Window Fourier Transform and Multiresolution Analysis	CO5, CO6
	B	Classify the Construction of Scaling Functions and Wavelets Using Multiresolution Analysis	CO5, CO6
	C,	Describe the Daubechies Wavelet, Wavelet Transform and Shannon Wavelet.	CO5, CO6
	Mode of examination	Theory	

	Weightage Distribution	CA:25%; ESE:75%	
	Text book/s*	1. Thomas and Finney; Calculus and Analytical Geometry, Narosa Publishing House.	
	Other References	1. Erwin Kreyszig; Advanced Engineering Mathematics, John Wiley & Sons, INC	

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
CMS404.1	3	3	2	2	-	2	-	-	-	-	-	-	3	-
CMS404.2	2	3	2	2	-	2	-	-	-	-	-	-	3	-
CMS404.3	2	2	2	2	-	2	-	-	-	-	-	-	3	-
CMS404.4	2	3	2	2	-	2	-	-	-	-	-	-	3	-
CMS404.5	3	2	2	2	-	2	-	-	-	-	-	-	3	-
CMS404.6	3	2	2	2	-	2	-	-	-	-	-	-	3	-
Average	**2.5**	**2.5**	**2.0**	**2.0**	**-**	**2.0**	**-**	**-**	**-**	**-**	**-**	**-**	**3.0**	**-**

School: SSBSR		**Batch: 2023-27**	
Programme: B.Sc. (Hons.)		**Academic Year: 2026-27**	
Branch: Mathematics		**Semester: VII**	
1	Course Code	**CMS405**	
2	Course Title	**Computational Commutative Algebra**	
3	Credits	**4**	
4	Contact Hours (L-T-P)	**4-0-0**	
	Course Status	**DSE**	
5	Course Objective	1.To familiarize the students with basic concepts of Computational Commutative Algebra and their applications. 2.To understand the different concept of Computational Commutative Algebra	
6	Course Outcomes	Students will be able to CO1: Explain the basic definitions, Quotient rings, division algorithm and solution of polynomial equation. (K1, K2, K3) CO2: Explain the Buchberger criterion, Modules, Localisation and Associated primes and other topics. (K2, K3, K4) CO3: Understand the concept of Saturation, Morphisms and Polynomial rings. (K3, K4) CO4: Understand the concept of Artinian rings, Graded modules, Hilbert polynomial and Hilbert-Samuel polynomial. (K3, K4, K5) CO5: Learn about the concept of degree and dimension of different polynomial rings. (K4, K5, K6) CO6: Learn about the concept of Algebras over a field, Hilbert series and Computing syzygies etc. (K5, K6)	
7	Course Description	This course is an introduction to the fundamental of Computational Commutative Algebra and their applications. The primary objective of the course is to develop the basic understanding of basic and advance form of algebra.	
8	**Outline syllabus**		**CO Mapping**
	Unit 1		
	A	Definitions, Homomorphisms, Quotient rings, Noetherian rings, Monomials.	CO 1
	B	Initial ideals, Division algorithm, Grobner basis.	CO 1
	C	Solving Polynomial Equations, Nullstellensatz.	CO 1
	Unit 2		

	A	Buchberger criterion, Monomial basis, Elimination, Modules.	CO 2
	B	Localisation, Nakayama Lemma, Spectrum.	CO 2
	C	Associated primes, Primary Decomposition, Support of a module, Prime avoidance	CO 2
	Unit 3		
	A	Saturation, Morphisms.	CO 3, CO 6
	B	Integral extensions, Noether normalisation lemma.	CO 3
	C	Polynomial rings, Going up theorem.	CO 3
	Unit 4		
	A	Artinian rings, Graded modules.	CO 4
	B	Hilbert polynomial, Hilbert-Samuel polynomial, Artin Rees Lemma	CO 4, CO 5
	C	Degree of Hilbert-Samuel polynomial, Dimension of noetherian local rings, Dimension of polynomial rings	CO 4, CO 5
	Unit 5		
	A	Algebras over a field, Graded rings, Polynomial rings over fields	CO 5, CO 6
	B	Hilbert series, Proj of a graded ring, Homogenization,	CO 5, CO 6
	C	Computing syzygies, Koszul complex, Castelnuovo Mumford regularity.	CO 5, CO 6
	Mode of examination	Theory	
	Weightage Distribution	CA:25%; ESE:75%	
	Text book/s*	1.) W. Vasconcelos, D. Eisenbud, et al. , Computational Methods in Commutative Algebra and Algebraic Geometry: 2 (Algorithms and Computation in Mathematics), Springer	
	Other References	1.) M. Kreuzer and L. Robbiano, Computational Commutative Algebra 1, Springer	

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO	**PO**	**PO**	**PO**	**PO**	**PO**	**PO**	**PO**	**PO**	**PO**	**PO**	**PS**	**PSO**	**PSO**	**PSO**
CO	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**
CMS405.1	3	3	2	2		2					2	2	3	
CMS405.2	2	3	2	2		2					2	2	3	
CMS405.3	2	2	2	2		2					2	2	3	
CMS405.4	2	3	2	2		2					2	2	3	
CMS405.5	3	2	2	2		2					2	2	3	
CMS405.6	3	2	2	2		2					2	2	3	
Average	**2.5**	**2.5**	**2.0**	**2.0**		**2.0**					**2.0**	**2.0**	**3.0**	

School: SSBSR		**Batch : 2023-27**	
Programme: B.Sc(Hons)		**Academic Year: 2026-27**	
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	**DSE**	
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 adjoint operator, self adjoint operator, Compact operators and write Riesz-Schauder theorem. (K1,K2,K6)	
7	Course Description	The primary objective of the course is to develop the understanding the normed linear spaces, bounded linear operator, open mapping and closedgraph theorems and Inner product spaces.	
8	Outline syllabus		CO Mapping
	Unit 1	**Normed linear spaces**	
	A	Normed linear spaces, Holder's inequality, Minkowski's inequality	CO1
	B	l^p -spaces, equivalence of norms, equivalence of 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 of complete 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, Compact operators	CO6
	C	Riesz-Schauder theorem, self-adjoint compact operators.	CO6
	Mode of examination	Theory	
	Weightage Distribution	CA:25%; ESE:75%	
	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	**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**
CO														
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: 2023-27**	
Programme: B.Sc. (Hons.)		**Academic Year: 2026-27**	
Branch: Mathematics		**Semester: VIII**	
1	Course Code	**CMS435**	
2	Course Title	**Algebraic Combinatorics**	
3	Credits	**4**	
4	Contact Hours (L-T-P)	**4-0-0**	
	Course Status	**DSE**	
5	Course Objective	1.To familiarize the students with basic concepts of Algebraic Combinatorics and their applications. 2.To understand the basic and advance version of algebra.	
6	Course Outcomes	Students will be able to: CO1: Understand the basic of Mobius inversion, Hasse Diagrams, Posets, Incidence algebra, Lattice, Partition and Weisner's Theorem. (K1, K2, K3). CO2: Understand the ideals, Formal Power Series, Multisets, sequences and Regular expressions. (K1, K2, K3). CO3: Explain the theory of finite automata, Kleene-Rabin-Scott Theorem, orbits, cycle index, combinatorial species and visualization of species. (K3, K4). CO4: Explain the theoretical concept of Species, Cayley's theorem, Endofunctions and LGV lemma. (K3, K4, K5) CO5: Describe the symmetric polynomials, Labelled abaci and Pieri rule, Triangularity of Kostka matrix. (K4, K5, K6) CO6: Describe monomial expansion, RSK, application of LGV lemma, inner product and Cauchy identity and Skew Schur functions with LR rule. (K5, K6)	
7	Course Description	This course is an introduction to the fundamental of Algebraic Combinatorics. The primary objective of the course is to develop the basic understanding of Mobius inversion, Posets, Lattice, Multisets, sequences, finite automata, Combinatorial species, LGV lemma, RSK and application of LGV lemma.	
8	**Outline syllabus**		**CO Mapping**
	Unit 1		
	A	Mobius Inversion, Partially Ordered Sets, Hasse Diagrams, Isomorphisms of Posets, Maximal, Minimal, Greatest, Least, Induced Subposets, Incidence Algebras, Inversion in Incidence Algebras	CO 1
	B	Mobius Inversion, Product Posets and their Mobius Functions, Opposite of a Poset, The Poset of Set Partitions, Connected Structures, Lattices, Weisner's Theorem, The Lattice of Non-Crossing Partitions	CO 1

	C	The Canonical Product Decoposition for Intervals of Non-Crossing Partitions, The Mobius Function for Non-Crossing Partitions,	CO 1
	Unit 2		
	A	Ideals in a Poset, Mobius Function of J(P), Young's Lattice, Distributive Lattices, Formal Power Series, The Necklace Problem.	CO 2
	B	Combinatorial Classes, Sums, Products, and Sequences of Combinatorial Classes, Power Set, Multisets, and Sequences, rooted trees, plane trees, binary trees, Catalan numbers	CO 2
	C	Super Catalan/Little Schroeder numbers, Regular expressions, unique matching, S-regular, recursive specification, restricted growth word,	CO 2
	Unit 3		
	A	finite automata, deterministic, non-deterministic, Kleene-Rabin-Scott Theorem (statement only), The Pumping Lemma, The Dyck Language, Permutations and their cycles, Permutation Groups,	CO 3, CO 6
	B	Orbits, fixed points, stabilizers, The orbit counting theorem, The Polya Enumeration Theorem, The Cycle Index Polynomials, Cycle Index of the Octahedral Group, Cycle Index of the Full Permutation Group.	CO 3, CO 6
	C	Combinatorial Species, Generating Series of a Species, Cycle Index Series of a Species, Isomorphism of Species, Visualization of Species, Sum of Species, Product of Species	CO 3, CO 4
	Unit 4		
	A	Substitution of Species, Derivative of a Species, Powers and Sequences of Binomial Type, Pointing and Cayley's Theorem, R-enriched Trees, R-enriched Endofunctions, Lagrange Inversion Forumla.	CO 4, CO 5
	B	Statement and Proof of the LGV Lemma, Nice Applications of the LGV Lemma, Sign-Reversing Involutions, The Cauchy-Binet Formula, Symmetric polynomials: definition and examples.	CO 4, CO 5
	C	Monomial symmetric polynomials, Elementary and Complete symmetric polynomials, Alternating polynomials, Labelled abaci and alternants, Schur polynomials.	CO 4, CO 5
	Unit 5		
	A	Pieri rule - statement with proof and examples, The second Pieri rule, Semi-standard tableaux, Triangularity of Kostka matrix.	CO 5, CO 6
	B	Monomial expansion of Schur, The RSK correspondence, Jacobi Trudi identities via LGV lemma, Formal ring of symmetric functions in infinitely many variables.	CO 5, CO 6
	C	Monomial expansions and RSK, Generating functions for e, h; The power sum symmetric functions, The inner product and Cauchy identity, Skew Schur functions and the LR rule.	CO 5, CO 6
	Mode of examination	Theory	
	Weightage	CA:25%; ESE:75%	

	Distribution		
	Text book/s*	1. M. Lothaire, Algebraic Combinatorics on words, Cambridge University Press.	
	Other References	1. R. P. Stanley, Algebraic Combinatorics: Walks, Trees, Tableaux, and More, Springer.	

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**
CMS435.1	3	3	2	2		2					2	2	3	
CMS435.2	2	3	2	2		2					2	2	3	
CMS435.3	2	2	2	2		2					2	2	3	
CMS435.4	2	3	2	2		2					2	2	3	
CMS435.5	3	2	2	2		2					2	2	3	
CMS435.6	3	2	2	2		2					2	2	3	
Average	**2.5**	**2.5**	**2.0**	**2.0**		**2.0**					**2.0**	**2.0**	**3.0**	

School: SSBSR		**Batch: 2023-26**
Programme: B.Sc. (Hons.)		**Academic Year: 2024-25**
Branch: Mathematics		**Semester: VIII**
1	Course Code	**CMS437**
2	Course Title	**Applied Linear Algebra in AI and ML**
3	Credits	4
4	Contact Hours (L-T-P)	4-0-0
	Course Status	DSE
5	Course Objective	1.To be familiarize students with the important concepts and computational techniques in linear algebra useful for AI and ML. 2.To understand the basic concept of Linear algebra, optimization techniques and statistical methods together form essential tools for most of the algorithms in artificial intelligence and machine learning.
6	Course Outcomes	Students will be able to: CO1: Explain the fundamental knowledge of Linear algebra and least squares solution, parameter estimation problems, concept of cost function. (K1,K2, K3). CO2: Explain the relation to parameter estimation, constrained least squares, multi-objective least squares, applications to portfolio optimization, (K2, K3, K4). CO3: Describe the sparse solutions to underdetermined systems of linear equations, applications to dictionary learning, eigenvalue eigenvector decomposition of square matrices, spectral theorem for symmetric matrices.(K3,K4,K5). CO4: Enumerate fundamentals of SVD, multicollinearity problem and applications to principal component analysis (PCA) and dimensionality reduction, power method, application to Google page ranking algorithm.(K2,K3,K4,K5) CO5: Describe the inverse eigenvalue problem, construction of Markov chains from the given stationary distribution, low rank approximation and structured low rank approximation problem (SLRA) (K3,K4,K5). CO6: Explain the fundamental knowledge of Autoregressive model order selection using Hankel SLRA, approximate GCD computation and application to image de- blurring, tensors and CP tensor decomposition, tensor decomposition based sparse learning in deep networks, matrix completion problems, application to collaborative filtering. (K4, K5, K6).
7	Course Description	In this course, we propose to build some background in these mathematical foundations and prepare students to take on advanced study or research in the field of AI and ML. The objective of this course is to familiarize

		students with the important concepts and computational techniques in linear algebra useful for AI and ML applications.	
8	**Outline syllabus**		**CO Mapping**
	Unit 1	**Vector Space and Linear Algebra**	
	A	Define the Vectors, operations on vectors, vector spaces and subspaces, inner product and vector norm.	CO1
	B	Find the linear dependence and independence, Matrices, linear transformations, orthogonal matrices.	CO1
	C	Solve the System of linear equations, existence and uniqueness, left and right inverses, pseudo inverse, triangular systems	CO1
	Unit 2	**Matrix LU Method and QR decomposition**	
	A	LU decomposition and computational complexity, rotators and reflectors, QR decomposition, Gram Schmidt Orthogonalization	CO2
	B	Condition number of a square matrix, geometric interpretation, norm of matrix, sensitivity analysis results for the system of linear equations.	CO2
	C	Linear least squares, existence and uniqueness, geometrical interpretation, data fitting with least squares.	CO2
	Unit 3	**Vector Regression Models:**	
	A	Find the Feature engineering, application to Vector auto-regressive models, fitting with continuous and discontinuous piecewise linear function.	CO3
	B	Application of least squares to classification, two-class and multi-class least squares classifiers.	CO3
	C	Explain the Polynomial classifiers, application to MNIST data set.	CO3
	Unit 4	**Least Square Method;**	
	A	Explain the Multi-objective least squares, applications to estimation and regularized inversion, regularized data fitting and application to image de-blurring, constrained least squares, application to portfolio optimization.	CO4
	B	Define the Eigenvalue eigenvector decomposition of square matrices, spectral theorem for symmetric matrices.	CO4
	C	Describe the SVD, relation to condition number, sensitivity analysis of least squares problems, variation in parameter estimates in regression.	CO4
	Unit 5	**PCA and application**	
	A	Define the Multicollinearity problem and applications to principal component analysis (PCA) and dimensionality reduction, power method, application to Google page ranking	CO5, CO6

		algorithm.	
	B	Underdetermined systems of linear equations, least norm solutions, sparse solutions, applications in dictionary learning and sparse code recovery, inverse eigenvalue problem, application in construction of Markov chains from the given stationary distribution	CO5, CO6
	C	Explain the Low rank approximation (LRA) and structured low rank approximation problem (SLRA), application to model order selection in time series, alternating projections for computing LRA and SLRA	CO5, CO6
	Mode of examination	Theory	
	Weightage Distribution	CA:25%; ESE:75%	
	Text book/s*	1.Introduction to Applied Linear Algebra- Vectors, Matrices, and Least Squares, Stephen Boyd and Lieven Vandenberghe, Cambridge University Press, 2018	
	Other References	1.Fundamentals of Matrix Computations, David Watkins, Wiley, 2010	

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO	**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**
CO														
CMS437.1	3	3	2	2		2				2	2	2	3	
CMS437.2	2	3	2	2		2				2	2	2	3	
CMS437.3	2	2	2	2		2				2	2	2	3	
CMS437.4	2	3	2	2		2				2	2	2	3	
CMS437.5	3	2	2	2		2				2	2	2	3	
CMS437.6	3	2	2	2		2				2	2	2	3	
Average	**2.5**	**2.5**	**2.0**	**2.0**		**2.0**				**2.0**	**2.0**	**2.0**	**3.0**	

School: SSBSR		**Batch: 2023-27**	
Programme: B.Sc. (Hons.)		**Academic Year: 2026-2027**	
Branch: Mathematics		**Semester: VIII**	
1	Course Code	**CMS436**	
2	Course Title	**Fourier Analysis and Its Applications**	
3	Credits	**4**	
4	Contact Hours (L-T-P)	**4-0-0**	
	Course Status	**DSE**	
5	Course Objective		
6	Course Outcomes	CO1. Discuss the basics of Fourier series of a given periodic function by evaluating Fourier coefficients.(K2, K3) CO2. Describe the concept of complex Fourier series of a function and to construct Fourier series for different range.(K2, K3) CO3. Define the harmonic analysis and the concept of Fourier series.(K1, K4) CO4. Calculate and analyze the Fourier integral and Fourier transform.(K3, K4) CO5. Explain and evaluate inverse Fourier transform of functions including unit step, sinusoidal etc. and convolution theorem(K3, K4, K5) CO6. Discuss and choose Fourier transform to solve partial differential equation and in communication systems.(K2, K6)	
7	Course Description	This course introduces the basics of Fourier Analysis as a prelude to applications. The course develops Fourier analysis from a general pure mathematical perspective leading to Fourier series, Fourier integrals and Fourier transform and then to applications such as partial differential equations, sampling.	
8	**Outline syllabus**		**CO Mapping**
	Unit 1	**Introduction**	
	A	Basic convergence Theorem , Pointwise convergence Theorem Convergence and divergence of Fourier series	CO1, CO2
	B	Fejer,s Theorem, Approximate identities, Dirichlet's Kernel, Poisson Kernel, Finding Fourier series coefficients	CO1, CO2
	C	Complex Fourier exponential series, Fourier coefficients for half range series	CO1, CO2
	Unit 2	**Applications**	
	A	Even and odd functions	CO3
	B	Differentiation and integration of Fourier series	CO3
	C	Harmonic Analysis and the concept of Fourier series	CO3
	Unit 3	**Fourier Integral and Transform**	

	A	Fatou’s theorem, Convergence and divergence of Fourier integral, kernels on R	CO4
	B	Fourier Integral calculation, complex form of Fourier Integral, Sine and cosine integral	CO4
	C	Fourier transform of periodic and non periodic functions	CO4
	Unit 4	**Inverse Fourier Transform**	
	A	Inverse transform of common functions including rectangular, Gaussian, delta, exponential decays, unit step, sinusoidal	CO5
	B	Convolution theorem and its application	CO5
	C	Parseval’s Theorem and energy spectral density	CO5
	Unit 5	**Applications of Fourier Analysis**	
	A	Fourier series and transforms in differential equations	CO6
	B	Fourier analysis in image processing	CO6
	C	Fourier analysis in communication systems	CO6
	Mode of examination	Theory	
	Weightage Distribution	CA:25%; ESE:75%	
	Text book/s*	1. H. Helson, “Harmonic Analysis”, Addison Wesley, 983, Hindustan Pub, 1994	
	Other References	1. G. B Folland, “Fourier Analysis and its applications”, Wadsworth and Brooks/cole	

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO	**PO**	**PO**	**PO**	**PO**	**PO**	**PO**	**PO**	**PO**	**PO**	**PO**	**PS**	**PSO**	**PSO**	**PSO**
CO	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**
CMS436.1	3	3	2	2	1	2				2	2	2	3	
CMS436.2	2	3	2	2	1	2				2	2	2	3	
CMS436.3	2	2	2	2	1	2				2	2	2	3	
CMS436.4	2	3	2	2	1	2				2	2	2	3	
CMS436.5	3	2	2	2	1	2				2	2	2	3	
CMS436.6	3	2	2	2	1	2				2	2	2	3	
Average	**2.5**	**2.5**	**2.0**	**2.0**	**1.0**	**2.0**				**2.0**	**2.0**	**2.0**	**3.0**	

School: SSBSR		**Batch: 2023-27**	
Programme: B.Sc. (Hons.)		**Academic Year: 2024-25**	
Branch: Mathematics		**Semester: III**	
1	Course Code	**BDA216**	
2	Course Title	**Statistical Inference**	
3	Credits	**3**	
4	Contact Hours (L-T-P)	**3-0-0**	
	Course Status	**DSE**	
5	Course Objective	To introduce concepts of statistical analysis of descriptive statistics, logic, and analytical tools, analyze and communicate quantitative data verbally, graphically, symbolically, and numerically. To make students familiar with the concept of Probability and Statistics and hypothesis.	
6	Course Outcomes	CO1: Describe the process of statistical analysis of descriptive statistics, the principle of least square, lines of regression, simple linear regression, and evaluate multiple linear regression, coefficient of multiple determination. (K2, K5) CO2: Describe the process of fitting polynomials and exponential curves. (K2) CO3: Explain the criteria for obtaining a good estimator. (K2, K3) CO4: Calculate and interpret the point estimation, confidence interval, and construction of confidence intervals using a pivotal, shortest expected length confidence interval. (K2, K3) CO5: Understand the null hypothesis, alternative hypothesis, type I error, type II error, level of significance, p-value, and power of the test, and develop the ability to use a one-sample t-test, two-sample t-test, and paired-sample t-test. Variance tests based on normal distribution one-sample and two-sample problems. (K2, K5) CO6: Develop the skills to interpret the results of statistical analysis by using the Z-test, F-test, and chi-square test for goodness of fit. One-way and Two-way analysis of variance (ANOVA) techniques. (K2, K5)	
7	Course Description	This is an advanced 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		
	A	Statistical analysis of descriptive statistics, the principle of least square, lines of regression, simple linear regression	CO1
	B	Coefficient of determination. Multiple linear regression, coefficient of multiple determination.	CO2
	C	Fitting of polynomials and exponential curves.	CO2
	Unit 2		
	A	Criteria for obtaining a good estimator: unbiasedness, consistency, efficiency, and sufficiency.	CO3
	B	Minimal sufficient statistic.	CO3
	C	Uniformly minimum variance unbiased estimator, complete statistic.	CO3
	Unit 3		
	A	Method of point estimation: Method of moments, maximum likelihood estimator, and its properties mean square error (MSE).	CO4
	B	Method of minimum chi-square, method of moments, Least square and their properties.	CO4

	C	Interval estimation: Confidence interval, construction of confidence intervals	CO4
	Unit 4		
	A	Null hypothesis, alternative hypothesis, type I error, type II error, level of significance, p-value, and power of the test.	CO5
	B	Tests for mean based on normal distribution- one-sample t-test, two-sample t-test, paired-sample t-test.	CO5
	C	Tests for variance based on normal distribution- one-sample and two-sample problem	CO5
	Unit 5		
	A	The large sample size test: Z-test, F-test, and Chi-square test for goodness of fit.	CO6
	B	One-way and Two-way analysis of variance (ANOVA) techniques.	CO6
	C	Statistical analysis of descriptive statistics, the principle of least square, lines of regression, simple linear regression	CO6
	Mode of examination	Theory	
	Weightage Distribution	CA:25%; ESE:75%	
	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**
BDA216.1	3	3	2	2		1					2		1	
BDA216.2	2	3	3	2		1					3		1	
BDA216.3	2	2	2	3		1					2		1	
BDA216.4	2	3	2	2		1					2		1	
BDA216.5	3	3	2	2		1					2		1	
BDA216.6	3	3	2	3		1					2		1	
Average	**2.3**	**2.6**	**2.0**	**2.1**		**1.0**					**2.0**		**1.0**	

School: SSBSR		**Batch: 2023-27**	
Programme: B.Sc. (Hons.)		**Academic Year: 2024-25**	
Branch: Mathematics		**Semester: III**	
1	Course Code	**BDA217**	
2	Course Title	**Data Preparation and Data Cleaning**	
3	Credits	3	
4	Contact Hours (L-T-P)	3-0-0	
	Course Status	DSE	
5	Course Objective	To make students familiar with the concepts of preparing your data; Working with dates and times, Data Cleaning, Data Structure, and cleaning Text Data.	
6	Course Outcomes	CO1: Describe preparing data: Rearranging and removing variables, renaming variables, Variable classes, calculating new numeric variables, and explaining how to Dividing a continuous variable into categories, and working with factor variables. (K1, K3) CO2: Discuss how to work with dates and times, adding and removing observations and explain about removing duplicate observations, selecting a subset of the data, selecting a random sample from a dataset, and sorting a dataset. (K2, K3, K4) CO3: Explain the data cleaning and technical representation of data. (K2, K3, K4) CO4: Discuss the data structure. (K2, K6) CO5: Describe Character Normalization, Encoding Conversion and Unicode Normalization, Character Conversion, and Transliteration. (K1, K2) CO6: Discuss and evaluate Generating Regular Expressions in R, Common String Processing Tasks in R, Approximate Text Matching, String Metrics, String Metrics, and Approximate Text Matching in R.	
7	Course Description	This course introduces preparing your data; Working with dates and times, Data Cleaning, Data Structure, and cleaning Text Data.	
8			
	Unit 1	**Summarizing Data and Tables**	
	A	Preparing your data: Rearranging and removing variables, renaming variables, Variable classes, Calculating new numeric variables,	CO1
	B	Dividing a continuous variable into categories, Working with factor variables,	CO1
	C	**Manipulating character variables:** Concatenating character strings, extracting a substring, Searching a character variable.	CO1
	Unit 2		
	A	Working with dates and times**,** Adding and removing observations,	CO2
	B	Removing duplicate observations, Selecting a subset of the data,	CO2
	C	Selecting a random sample from a dataset, Sorting a dataset.	CO2
	Unit 3		
	A	**Data Cleaning:** The Statistical Value Chain, Raw Data, Input Data, Valid Data, Statistics, and Output.	CO3
	B	Technical Representation of Data: Numeric Data, Integers, Integers in R, Real Numbers, Double Precision Numbers, The Concept of Machine Precision, Consequences of Working with Floating Point Numbers, Dealing with the Consequences,	CO3

	C	Numeric Data in R. Text Data. Terminology and Encodings. Unicode. Textual Data in R: Objects of Class Character. Encoding in R. Reading, and Writing of Data with Non-Local Encoding. Detecting Encoding. Collation, and Sorting. Times and Dates. Time and Date Notation. Time and Date Storage in R. Time and Date Conversion in R, Leap Days, Time Zones, and Daylight-Saving Times.	CO3
	Unit 4		
	A	**Data Structure:** Introduction, Tabular Data, data.frame, Databases, dplyr, Matrix Data, Time Series,	CO4
	B	Graph Data, Web Data, Web Scraping, Web API, Other Data, Tidying Tabular Data,	CO4
	C	Variable Per Column, Single Observation Stored in Multiple Tables.	CO4
	Unit 5		
	A	Cleaning Text Data: Character Normalization. Encoding Conversion and Unicode Normalization, Character Conversion and Transliteration,	CO5,
	B	Pattern Matching with Regular. Expressions. Basic Regular Expressions. Practical Regular Expressions, Generating Regular Expressions in R,	CO5
	C	Common String Processing Tasks in R. Approximate Text Matching. String Metrics, String Metrics, and Approximate Text Matching in R.	CO6
	Mode of examination	Practical Based	
	Weightage Distribution	CA:25%; ESE:75%	
	Text book/s*	1. Bad Data Handbook: Cleaning Up the Data So You Can Get Back to Work by Q. Ethan McCallum	
	Other References	1. Data Wrangling with Python by Jacqueline Kazil	

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**
BDA217.1		2	1	2		1		3			1	1	1	
BDA217.2		2	1	2		1		3			1	1	1	
BDA217.3		2	1	2		1		3			1	1	1	
BDA217.4		2	1	2		1		3			1	1	1	
BDA217.5		2	1	2		1		3			1	1	1	
BDA217.6		2	1	2		1		3			1	1	1	
Average		**2.0**	**1.0**	**2.0**		**1.0**		**3.0**			**1.0**	**1.0**	**1.0**	

School: SSBSR		**Batch: 2023-27**	
Programme: B.Sc. (Hons.)		**Academic Year: 2024-25**	
Branch: Mathematics		**Semester: III**	
1	Course Code	**BDA261**	
2	Course Title	**Statistical Inference Lab**	
3	Credits	1	
4	Contact Hours (L-T-P)	0-0-2	
	Course Status	DSE	
5	Course Objective	To introduce concepts of statistical analysis of descriptive statistics, logics, and analytical tools, analyze and communicate quantitative data verbally, graphically, symbolically, and numerically. To make students familiar with the concept of Probability and Statistics and hypothesis.	
6	Course Outcomes	CO1: Describe the process of statistical analysis of descriptive statistics, the principle of least square, lines of regression, simple linear regression, and evaluate multiple linear regression, coefficient of multiple determination. (K2, K5) CO2: Describe the process of fitting of polynomials and exponential curves. (K2) CO3: Explain the criteria for obtaining a good estimator. (K2, K3) CO4: Calculate and interpret the point estimation, confidence interval, and construction of confidence intervals using a pivotal, shortest expected length confidence interval. (K2, K3) CO5: Understand the null hypothesis, alternative hypothesis, type I error, type II error, level of significance, p-value, and power of the test, and develop the ability to use a one-sample t-test, two-sample t-test, and paired-sample t-test. Tests for variance based on normal distribution – one-sample and two-sample problem. (K2, K5) CO6: Develop the skills to interpret the results of statistical analysis by using the Z-test, F-test, and Chi-square test for goodness of fit. One-way and Two-way analysis of variance (ANOVA) techniques. (K2, K5)	
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 on the principle of least square, Simple linear regression, Multiple linear regression	CO1
	Unit 2	**Lab. Experiment 2**	
	A, B, C	Problem-based on obtaining a good estimator: Unbiasedness, Consistency, Efficiency, Sufficiency.	CO2
	Unit 3	**Lab. Experiment 3**	
	A, B, C	Problem-based on Point and Interval Estimation.	CO3
	Unit 4	**Lab. Experiment 4**	
	A, B, C	Problem-based on Hypothesis Testing.	CO4
	Unit 5	**Lab. Experiment 5**	
	A, B, C	Problem-based on One-way and Two-way analysis of variance (ANOVA) techniques.	CO5, CO6

	Mode of examination	Practical+Viva	
	Weightage Distribution	CA:25%; CE:25%; ESE:50%	
	Text book/s*	1. Goon A.M., Gupta M.K. and Dasgupta B. (2008): Fundamentals of Statistics, World Press.	
	Other References	1. Daniel, Wayne W., "Biostatistics": Basic Concept and Methodology forHealth Science.	

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
BDA261.1	1	2	2	2		1	1	3	1	2	2	1	2	2
BDA261.2	1	2	3	2		1	1	3	1	2	2	1	2	2
BDA261.3	1	2	2	2		1	1	3	1	2	2	1	2	2
BDA261.4	1	2	2	2		1	1	3	1	2	2	1	2	2
BDA261.5	1	2	2	2		1	1	3	1	2	2	1	2	2
BDA261.6	1	2	2	2		1	1	3	1	2	2	1	2	2
Average	**1.0**	**2.0**	**2.0**	**2.0**		**1.0**	**1.0**	**3.0**	**1.0**	**2.0**	**2.0**	**1.0**	**2.0**	**2.0**

School: SSBSR		**Batch: 2023-27**	
Programme: B.Sc. (Hons.)		**Academic Year: 2024-25**	
Branch: Mathematics		**Semester: IV**	
1	Course Code	**BDA202**	
2	Course Title	**Data Base Management Systems**	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
	Course Status	DSE	
5	Course Objective	To make students familiar with the basic concepts of Databases and Transactions and Data Models, Database Design, ER-Diagram and Unified Modeling Language, Relational Algebra and Calculus, Constraints, Views and SQL, Transaction management, and Concurrency control.	
6	Course Outcomes	CO1: Discuss the basics of Databases and Transactions and Data Models. (K1, K2, K3) CO2: Discuss about Database Design, ER-Diagram, and Unified Modeling Language. (K1, K3) CO3: Explain relational algebra and calculus, describe Domain relational Calculus, calculus vs algebra, and computational capabilities. (K3, K4) CO4: Explain and illustrate Constraints, Views, and SQL. (K3, K6) CO5: Evaluate different types of transaction management. (K4, K5) CO6: Explain concurrency control, time stamping methods, optimistic methods, and database recovery management. (K2, K4, K5)	
7	Course Description	This course introduces the basic concepts of Databases and Transactions and Data Models, Database Design, ER-Diagram and Unified Modeling Language, Relational Algebra and Calculus, Constraints, Views and SQL, Transaction management, and Concurrency control.	
8	**Outline syllabus**		**CO Mapping**
	Unit 1	**Introduction to Databases and Transactions and Data Models**	
	A	What is a database system, purpose of the database system, what view of data, relational databases, database architecture.	CO1
	B	Transaction management, The importance of data models, Basic building blocks,	CO1
	C	Business rules, The evolution of data models, Degrees of data abstraction.	CO1
	Unit 2	**Database Design, ER-Diagram, and Unified Modeling Language**	
	A	Database design and ER Model: overview, ER-Model, Constraints, ER-Diagrams, ERD Issues, weak entity sets, Codd's rules, Relational Schemas,	CO2
	B	Introduction to UML Relational database model: Logical view of data, keys, integrity rules.	CO2
	C	Relational Database design: features of good relational database design, atomic domain, and Normalization (1NF, 2NF, 3NF, BCNF).	CO2
	Unit 3	**Relational Algebra and Calculus**	
	A	Relational algebra: introduction, Selection, and projection, set operations, renaming, Joins, Division, syntax, semantics.	CO3
	B	Operators, grouping and ungrouping, relational comparison.	CO3
	C	Calculus: Tuple relational calculus, Domain relational Calculus, calculus vs algebra, computational capabilities.	CO3
	Unit 4	**Constraints, Views, and SQL**	
	A	What are constraints, types of constraints, and Integrity constraints?	CO4
	B	Views: Introduction to views, data independence, security, updates on views, and comparison between tables.	CO4
	C	Views SQL: data definition, aggregate function, Null Values,	CO4

		nested subqueries, Joined relations. Triggers.	
	Unit 5	**Transaction management and Concurrency control**	
	A	Transaction management: ACID properties, serializability, and concurrency control,	CO5, CO6
	B	Lock-based concurrency control (2PL, Deadlocks), Time stamping methods.	CO5, CO6
	C	Optimistic methods, database recovery management.	CO5, CO6
	Mode of examination	Theory	
	Weightage Distribution	CA:25%; ESE:75%	
	Text book/s*	1."Database System Concepts", 6th Edition by Abraham Silberschatz, Henry F. Korth, S. Sudarshan, McGraw-Hill	
	Other References	1 "Principles of Database and Knowledge – Base Systems", Vol 1 by J. D. Ullman, Computer science 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
BDA202.1	3	3	2	2		1					1			1
BDA202.2	2	3	3	2		1					1			1
BDA202.3	2	2	2	3		1					1			1
BDA202.4	2	3	2	2		1					1			1
BDA202.5	3	3	2	2		1					1			1
BDA202.6	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: 2023-27	
Programme: B.Sc. (Hons.)		**Academic Year: 2024-25**	
Branch: Mathematics		**Semester: IV**	
1	Course Code	**BDA214**	
2	Course Title	**Sampling Theory**	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
	Course Status	DSE	
5	Course Objective	To make students familiar with the concept of sample and population, complete enumeration versus sampling. The concept of Systematic Sampling, estimates of the population mean and total, variances of these estimates along with the brief of the present official statistical system in India, methods of collection of official statistics, their reliability, and limitations have been introduced.	
6	Course Outcomes	CO1: Explain and illustrate the concepts of sample and population. (K2, K3, K4) CO2: Describe the properties of complete enumeration versus sampling; explain random sampling with and without replacement. (K1, K2, K3) CO3: Describe estimates of the population mean, explain its application and estimates of these variances, and sample size determination. (K2, K3, K4) CO4: Describe stratified random sampling, estimates of the population mean and total and explain its application, and illustrate systematic sampling. (K2, K3, K4) CO5: Describe the ratio and regression methods of estimation and evaluate variances in terms of the correlation coefficient between X and Y for the regression method and their comparison with SRS. (K2, K3, K6) CO6: Describe and analyze the basic concepts present official statistical system in India, and methods of collection of official statistics. (K1, K2, K4)	
7	Course Description	This course initiates the advanced concept of sample and population, complete enumeration versus sampling. The concept of Systematic Sampling, estimates of the population mean and total, variances of these estimates along with the brief of the present official statistical system in India, methods of collection of official statistics, their reliability, and limitations have been introduced.	
8			
	Unit 1		
	A	Concept of sample and population, complete enumeration versus sampling	CO1
	B	Sampling and non-sampling errors, requirements of a good sample,	CO1
	C	Simple random sampling with and without replacement.	CO2
	Unit 2		
	A	Estimates of the population mean, total, and proportion,	CO3
	B	Variances of these estimates	CO3
	C	Estimates of theses variances and sample size determination.	CO3
	Unit 3		
	A	Stratified random sampling, estimates of the population mean, and total variances of these estimates.	CO4
	B	Proportional and optimum allocations and their comparison with SRS.	CO4
	C	Systematic Sampling, estimates of the population mean and total, variances of these estimates.	CO4

	Unit 4		
	A	Ratio and regression methods of estimation, estimates of the population mean and total (for SRS of large size),	CO5
	B	Variances of these estimates and estimates of theses variances,	CO5
	C	Variances in terms of the correlation coefficient between X and Y for regression method and their comparison with SRS.	CO5
	Unit 5		
	A	Present official statistical system in India, Methods of collection of official statistics, their reliability and limitations.	CO6
	B	Principal publications containing data on the topics such as population, industry, and finance.	CO6
	C	Various official agencies are responsible for data collection and their main functions.	CO6
	Mode of examination	Theory	
	Weightage Distribution	CA:25%; ESE:75%	
	Text book/s*	1. Goon A.M., Gupta M.K. and Dasgupta B (2001): Fundamentals of Statistics (Vol.2), Word Press.	
	Other References	1. Cochran W.G (1984): Sampling Techniques (3rd Ed.), Wiley Eastern..	

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**
BDA214.1	3	3	2	2		1					1	1	1	
BDA214.2	2	3	3	2		1					1	1	1	
BDA214.3	2	2	2	3		1					1	1	1	
BDA214.4	2	3	2	2		1					1	1	1	
BDA214.5	3	3	2	2		1					1	1	1	
BDA214.6	3	3	2	3		1					1	1	1	
Average	**2.3**	**2.6**	**2.0**	**2.1**		**1.0**					**1.0**	**1.0**	**1.0**	

School: SSBSR		**Batch: 2023-27**	
Programme: B.Sc. (Hons.)		**Academic Year: 2024-25**	
Branch: Mathematics		**Semester: III**	
1	Course Code	**BDA262**	
2	Course Title	**Data Preparation and Data Cleaning Lab**	
3	Credits	1	
4	Contact Hours(L-T-P)	0-0-2	
	Course Status	DSE	
5	Course Objective	To make students familiar with the concepts of preparing your data; Working with dates and times, Data Cleaning, Data Structure, and Cleaning Text Data.	
6	Course Outcomes	CO1: Describe preparing data: Rearranging and removing variables, renaming variables, Variable classes, calculating new numeric variables, and explaining how to Dividing a continuous variable into categories, Working with factor variables. (K1, K3) CO2: Discuss how to work with dates and times, add and remove observations and explain about removing duplicate observations, selecting a subset of the data, selecting a random sample from a dataset, and sorting a dataset. (K2, K3, K4) CO3: Explain the data cleaning and technical representation of data. (K2, K3, K4) CO4: Discuss the data structure. (K2, K6) CO5: Describe Character Normalization, Encoding Conversion and Unicode Normalization, Character Conversion, and Transliteration. (K1, K2) CO6: Discuss and evaluate Generating Regular Expressions in R, Common String Processing Tasks in R, Approximate Text Matching, String Metrics, String Metrics, and Approximate Text Matching in R.	
7	Course Description	This course introduces preparing your data; Working with dates and times, Data Cleaning, Data Structure, and cleaning Text Data.	
8	**Outline syllabus**		**CO Mapping**
	Unit 1	**Lab. Experiment 1**	
	A, B, C	Problem-based on data collection and source of error.	CO1, CO2
	Unit 2	**Lab. Experiment 2**	
	A, B, C	Problem-based on screening, diagnosis, and treatment of data.	CO2, CO3
	Unit 3	**Lab. Experiment 3**	
	A, B, C	Problem-based on missing value and record value.	CO3, CO4
	Unit 4	**Lab. Experiment 4**	

	A, B, C	Problem-based on quality control procedure, and data Integration.	CO4, CO5
	Unit 5	**Lab. Experiment 5**	
	A, B, C	Problem-based on tools and techniques for data cleaning.	CO5, CO6
	Mode of examination	Practical + Viva	
	Weightage Distribution	CA:25%; CE:25%; ESE:50%	
	Text book/s*	1. Bad Data Handbook: Cleaning Up the Data So You Can Get Back to Work by Q. Ethan McCallum	
	Other References	1. Data Wrangling with Python by Jacqueline Kazil	

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**
BDA262.1	1	2	2	2		1	1	3	1	1	2	1	2	2
BDA262.2	1	2	3	2		1	1	3	1	1	2	1	2	2
BDA262.3	1	2	2	2		1	1	3	1	1	2	1	2	2
BDA262.4	1	2	2	2		1	1	3	1	1	2	1	2	2
BDA262.5	1	2	2	2		1	1	3	1	1	2	1	2	2
BDA262.6	1	2	2	2		1	1	3	1	1	2	1	2	2
Average	**1.0**	**2.0**	**2.0**	**2.0**		**1.0**	**1.0**	**3.0**	**1.0**	**1.0**	**2.0**	**1.0**	**2.0**	**2.0**

School: SSBSR		**Batch: 2023-27**	
Programme: B.Sc. (Hons.)		**Academic Year: 2024-25**	
Branch: Mathematics		**Semester: IV**	
1	Course Code	**BDA271**	
2	Course Title	**Data Base Management Systems Lab**	
3	Credits	1	
4	Contact Hours (L-T-P)	0-0-2	
	Course Status	DSE	
5	Course Objective	To make students familiar with the data structure & algorithms. The concept of data organizations, data structure operations; analysis of an algorithm; Stacks and Queues; Linked Lists; Sorting and Hashing; Graph.	
6	Course Outcomes	CO1: Explain and illustrate the concepts of basic terminologies: elementary data organizations, data structure operations: insertion, deletion, traversal, etc. (K2, K3, K4) CO2: Describe the analysis of an algorithm, asymptotic; notations, time-space trade-off. (K1, K2, K3) CO3: Describe Linear Search and Binary Search Techniques and explain their complexity analysis. (K2, K3, K4) CO4: Describe ADT Stack and its operations: Algorithms and their complexity analysis, Applications of Stacks; Types of Queue; Algorithms and their analysis. (K2, K3, K4) CO5: Describe the Singly-linked lists; trees; algorithms and analysis. (K2, K3, K6) CO6: Describe and analyze the basic concepts of Sorting and Hashing; Graphs. (K1,K2, K4)	
7	Course Description	This course introduces data structure & algorithms. The concept of data organizations, data structure operations; analysis of an algorithm; Stacks and Queues; Linked Lists; Sorting and Hashing; Graph.	
8	**Outline syllabus**		**CO Mapping**
	Unit 1		
	A, B, C	Problem-based on uses functions to perform the following operations on a singly linked list i) Creation ii) Insertion iii) Deletion iv) Traversal. Problem-based on uses functions to perform the following operations on the doubly linked list i) Creation ii) Insertion iii) Deletion iv) Traversal.	CO1, CO2
	Unit 2		
	A, B, C	Problem-based on uses functions to perform the following operations on circular linked List i) Creation ii) Insertion iii) Deletion iv) Traversal. Problem-based on implement stack (its operations) using i) Arrays ii) Linked list(Pointers).	CO1, CO3
	Unit 3		

	A, B, C	Problem-based on implementing Queue (its operations) using i) Arrays ii) Linked list (Pointers). Problem-based on implementing Circular Queue using arrays. Problem-based on both recursive and nonrecursive functions to perform the following searching operations for a Key value in a given list of integers: a) Linear search b) Binary search.	CO1, CO4
	Unit 4		
	A, B, C	Problem-based on implements the following sorting i) Bubble sort ii) Selection sort iii) Quick sort. Problem-based on implements the following i) Insertion sort ii) Merge sort iii) Heap sort. Problem-based on implementing all the functions of a dictionary (ADT) using Linked List.	CO5
	Unit 5		
	A, B, C	Problem-based on performing the following operations: a) Insert an element into a binary search tree. b) Delete an element from a binary search tree. c) Search for a key element in a binary search tree. Problem-based on to implement the tree traversal methods. Problem-based on performing the following operations: a) Insert an element into an AVL tree. b) Delete an element from an AVL tree. c) Search for a key element in an AVL tree.	CO5, CO6
	Mode of examination	Practical+Viva	
	Weightage Distribution	CA:25%; CE:25%; ESE:50%	
	Text book/s*	1. Fundamentals of Data Structures", Illustrated Edition by Ellis Horowitz, SartajSahni, Computer Science Press.	
	Other References	1. Algorithms, Data Structures, and Problem-Solving with C++", Illustrated Edition by Mark Allen Weiss, Addison-Wesley Publishing 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
BDA271.1	1	2	2	2		1	1	3	1	2	2	1		2
BDA271.2	1	2	3	2		1	1	3	1	2	2	1		2
BDA271.3	1	2	2	2		1	1	3	1	2	2	1		2
BDA271.4	1	2	2	2		1	1	3	1	2	2	1		2
BDA271.5	1	2	2	2		1	1	3	1	2	2	1		2
BDA271.6	1	2	2	2		1	1	3	1	2	2	1		2
Average	**1.0**	**2.0**	**2.0**	**2.0**		**1.0**	**1.0**	**3.0**	**1.0**	**2.0**	**2.0**	**1.0**		**2.0**

School: SSBSR		**Batch: 2023-27**	
Programme: B.Sc. (Hons.)		**Academic Year: 2024-25**	
Branch: Mathematics		**Semester: IV**	
1	Course Code	**BDA272**	
2	Course Title	**Sampling Theory Lab**	
3	Credits	1	
4	Contact Hours (L-T-P)	0-0-2	
	Course Status	DSE	
5	Course Objective	This course initiates the advanced concept of sample and population, complete enumeration versus sampling. The concept of Systematic Sampling, estimates of the population mean and total, variances of these estimates along with the brief of the present official statistical system in India, methods of collection of official statistics, their reliability, and limitations have been introduced.	
6	Course Outcomes	CO1: Explain and illustrate the concepts of sample and population. (K2, K3, K4) CO2: Describe the properties of complete enumeration versus sampling; explain random sampling with and without replacement. (K1, K2, K3) CO3: Describe estimates of the population mean, explain its application and estimates of these variances, and sample size determination. (K2, K3, K4) CO4: Describe stratified random sampling, estimates of the population mean and total and explain its application, and illustrate systematic sampling. (K2, K3, K4). CO5: Describe the ratio and regression methods of estimation and evaluate variances in terms of the correlation coefficient between X and Y for the regression method and their comparison with SRS. (K2, K3, K6). CO6: Describe and analyze the basic concepts present official statistical system in India, and methods of collection of official statistics. (K1,K2, K4).	
7	Course Description	This is an advanced 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 on how to draw the sample from the population in SRSWR and SRSWOR	CO1, CO2
	Unit 2	**Lab. Experiment 2**	
	A, B, C	Problem-based on simple random sampling and find that SRSWOR performs better than SRSWR	CO1, CO3
	Unit 3	**Lab. Experiment 3**	
	A, B, C	Problem-based on stratified random sampling	CO1, CO4

	Unit 4	**Lab. Experiment 4**	
	A, B, C	Problem-based on systematic sampling	CO5
	Unit 5	**Lab. Experiment 5**	
	A, B, C	Problem-based on ratio and regression type estimator.	CO6
	Mode of examination	Practical+Viva	
	Weightage Distribution	CA:25%; CE:25%; ESE:50%	
	Text book/s*	1. Goon A.M., Gupta M.K. and Dasgupta B (2001): Fundamentals of Statistics (Vol.2), Word Press.	
	Other References	1. Cochran W.G (1984): Sampling Techniques (3rd Ed.), Wiley Eastern.	

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**
BDA272.1	1	2	2	2		1	1	3	1		2	1		2
BDA272.2	1	2	3	2		1	1	3	1		2	1		2
BDA272.3	1	2	2	2		1	1	3	1		2	1		2
BDA272.4	1	2	2	2		1	1	3	1		2	1		2
BDA272.5	1	2	2	2		1	1	3	1		2	1		2
BDA272.6	1	2	2	2		1	1	3	1		2	1		2
Average	**1.0**	**2.0**	**2.0**	**2.0**		**1.0**	**1.0**	**3.0**	**1.0**		**2.0**	**1.0**		**2.0**

School: SSBSR		**Batch: 2023-27**	
Programme: B.Sc. (Hons.)		**Academic Year: 2025-26**	
Branch: Mathematics		**Semester: V**	
1	Course Code	**BDA320**	
2	Course Title	**Advanced Statistical Analysis**	
3	Credits	2	
4	Contact Hours (L-T-P)	2-0-0	
	Course Status	DSE	
5	Course Objective	After completing this course, students are expected to become a specialist to analyze the observed phenomena at in advanced statistical level. More importantly, students are expected to provide an analytical solution to a problem using appropriately selected models and data and discover meaningful knowledge from thesolution.	
6	Course Outcomes	CO1: Describe how to Differentiate various probability distributions. (K1, K2) CO2: Understand the concept of estimation. (K2, K3) CO3: Know how to recognize the sampling distributions. (K2, K3) CO4: Learn non-parametric tests such as the chi-Square test for Independence as well as Goodness of Fit. (K3, K4) CO5: Know how to apply various statistics and analyses. (K3, K4, K5) CO6: Able to know statistical technique implantation in a practical situation. (K3, K4, K5)	
7	Course Description	This course provides students with the statistical foundation of the various problems ofreal life. Students will learn to recognize the main features of the processes under investigation that could be analyzed in terms of advanced statistical approaches. Grading this course will help the future specialist to analyze the observed phenomena in advanced statistical level.	
8			**CO Mapping**
	Unit 1		
	A	Use of discrete distribution (Uniform, Binomial, and Poisson) in real-life problems.	CO1
	B	Use of continuous distribution (Normal, Exponential, and Gamma) in real-life problems.	CO1
	C	Its applications in Industrial work.	CO1
	Unit 2		
	A	Sampling Distributions.	CO2

	B	χ2 distribution properties and Interrelationships.	CO2
	C	t distribution properties and Interrelationships.	CO2
	Unit 3		
	A	F distribution properties.	CO3
	B	Interrelationship of χ2, t, F distributions.	CO3, CO6
	C	Point Estimation, Interval estimation for mean, the variance of normalpopulation, and proportion of the binomial population.	CO3, CO6
	Unit 4		
	A	Type I and Type II errors, Critical Region, Size of the test, P value,Power.	CO4, CO6
	B	Large Sample test -Z test.	CO4, CO6
	C	Large Sample test – Chi-Square test-goodness of fit, the test of independence.	CO4, CO6
	Unit 5		
	A	ANOVA,	CO5, CO6
	B	Cluster and Principal Components Analysis (PCA).	CO5, CO6
	C	Factor Analysis, Canonical Correlation	CO5, CO6
	Mode of examination	Practical Based	
	Weightage Distribution	CA:25%; ESE:75%	
	Text book/s*	1. Westfall, P., & Henning, K. S. (2013): Understanding advanced statistical methods. CRC Press.	
	Other References	1. Croxton, Fredrick E., Cowden, Dudley J. and Klein, S. (1973): Applied General Statistics, 3rd Edition. Prentice Hall of India Pvt. Ltd.	

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
BDA320.1		2	1	2		1		3		2	2		1	1
BDA320.2		2	1	2		1		3		2	2		1	1
BDA320.3		2	1	2		1		3		2	2		1	1
BDA320.4		2	1	2		1		3		2	2		1	1
BDA320.5		2	1	2		1		3		2	2		1	1
BDA320.6		2	1	2		1		3		2	2		1	1
Average		**2.0**	**1.0**	**2.0**		**1.0**		**3.0**		**2.0**	**2.0**		**1.0**	**1.0**

School: SSBSR	**Batch: 2023-27**		
Programme: B.Sc. (Hons.)	**Academic Year: 2025-26**		
Branch: Mathematics	**Semester: V**		
1	Course Code	**BDA321**	
2	Course Title	**Experimental Design**	
3	Credits	2	
4	Contact Hours (L-T-P)	2-0-0	
	Course Status	DSE	
5	Course Objective	The course objective is to learn how to plan, design and conduct experiments efficiently and effectively, and analyze the resulting data to obtain objective conclusions.	
6	Course Outcomes	After the completion of this course, the student will be able to CO1: Build knowledge of basic principles of design of experiment. CO2: Make use of the concept to various simple types of experimental designs. CO3: Make use of the concept to f complex types of experimental designs. CO4: Evaluate the factorial experiment, confounding and split/strip plot design. CO5: Apply concept of missing-plot techniques, cross-over design, and transformation of data and response question. CO6: How to *design* and conduct *experiments*, and how to analyze them properly to answer various *research* questions	
7	Course Description	The course objective is to learn how to plan, design and conduct experiments efficiently and effectively, and analyze the resulting data to obtain objective conclusions.	
8			**CO Mapping**
	Unit 1		
	A	Analysis of variance,	CO1
	B	Basic principles of design of experiments.	CO1
	C	Uniformity trials.	CO1
	Unit 2		
	A	Completely randomized design (CRD),	CO2
	B	Randomized complete block design (RCBD),	CO2
	C	Latin square design (LSD)	CO2
	Unit 3		
	A	Balanced incomplete block (BIB) design,	CO3
	B	Resolvable block designs and their applications	CO3

	C	Randomization procedure, analysis and interpretation of results.	CO3
	Unit 4		
	A	Factorial experiments,	CO4
	B	Confounding in factorial experiments-application in 2n and 3n factorial experiments.	CO4
	C	Factorial experiments with extra treatment(s). Split plot and Strip plot designs	CO4
	Unit 5		
	A	Groups of experiments. Analysis of covariance.	CO5, CO6
	B	Missing plot technique and its application to RCBD, LSD. Cross-over design. Sampling in field experiments.	CO5, CO6
	C	Transformation of data. Response surfaces. Experiments with mixtures.	CO5, CO6
	Mode of examination	Practical Based	
	Weightage Distribution	CA:25%; ESE:75%	
	Text book/s*	1. Westfall, P., & Henning, K. S. (2013): Understanding advanced statistical methods. CRC Press.	
	Other References	1. Cochran,W.G.andCox,G.M.1957.ExperimentalDesigns.John WileyandSons.	

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**
BDA321.1		2	1	2		1		3			2		1	1
BDA321.2		2	1	2		1		3			2		1	1
BDA321.3		2	1	2		1		3			2		1	1
BDA321.4		2	1	2		1		3			2		1	1
BDA321.5		2	1	2		1		3			2		1	1
BDA321.6		2	1	2		1		3			2		1	1
Average		**2.0**	**1.0**	**2.0**		**1.0**		**3.0**			**2.0**		**1.0**	**1.0**

School: SSBSR		**Batch: 2023-27**	
Programme: B.Sc. (Hons.)		**Academic Year: 2025-26**	
Branch: Mathematics		**Semester: V**	
1	Course Code	**BDA363**	
2	Course Title	**Experimental Design Lab**	
3	Credits	1	
4	Contact Hours (L-T-P)	0-0-2	
	Course Status	DSE	
5	Course Objective	The course objective is to learn how to plan, design and conduct experiments efficiently and effectively, and analyze the resulting data to obtain objective conclusions.	
6	Course Outcomes	After the completion of this course, the student will be able to CO1: Build knowledge of basic principles of design of experiment. CO2: Make use of the concept to various simple types of experimental designs. CO3: Make use of the concept to f complex types of experimental designs. CO4: Evaluate the factorial experiment, confounding and split/strip plot design. CO5: Apply concept of missing-plot techniques, cross-over design, and transformation of data and response question. CO6: How to *design* and conduct *experiments*, and how to analyze them properly to answer various *research* questions	
7	Course Description	The course objective is to learn how to plan, design and conduct experiments efficiently and effectively, and analyze the resulting data to obtain objective conclusions.	
8	**Outline syllabus**		**CO Mapping**
	Unit 1		
	A, B, C	Problem based on uniformity trial data analysis, formation of plots and blocks.	CO1
	Unit 2		
	A, B, C	Problem based on Fair field Smith Law, Analysis of data obtained from CRD, RBD, LSD	CO2
	Unit 3		
	A, B, C	Problem based on analysis of factorial experiments without and with confounding.	CO3
	Unit 4		
	A, B, C	Problem based on Analysis of Covariance	CO4, CO5
	Unit 5		
	A, B, C	Analysis with missing data, Split plot and strip plot designs.	CO6
	Mode of examination	Practical+Viva	
	Weightage Distribution	CA:25%; CE:25%; ESE:50%	
	Text book/s*	1. Westfall, P., & Henning, K. S. (2013): Understanding advanced statistical methods. CRC Press.	
	Other References	1.Gomez,K.A.andGomez,A.A.1984.StatisticalProceduresforAgriculturalResearch.JohnWiley&Sons.	

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
BDA363.1	1	2	2	2		1	1	3	1			1	2	
BDA363.2	1	2	3	2		1	1	3	1			1	2	
BDA363.3	1	2	2	2		1	1	3	1			1	2	
BDA363.4	1	2	2	2		1	1	3	1			1	2	
BDA363.5	1	2	2	2		1	1	3	1			1	2	
BDA363.6	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: 2023-27**	
Programme: B.Sc. (Hons.)		**Academic Year: 2025-26**	
Branch: Mathematics		**Semester: V**	
1	Course Code	**BDA359**	
2	Course Title	**Advanced Statistical Analysis Lab**	
3	Credits	1	
4	Contact Hours (L-T-P)	0-0-2	
	Course Status	DSE	
5	Course Objective	After completing this course, students are expected to become a specialist to analyze the observed phenomena at in advanced statistical level. More importantly, students are expected to provide an analytical solutions to a problem using appropriately selected models and data and discover meaningful knowledge from thesolution.	
6	Course Outcomes	CO1: How to read, understand and trace the execution of programs written in C language. (K2,K3, K4). CO2: Apply c programming knowledge to convert the algorithm into the program in C(K2, K3, K4). CO3: Maximize the knowledge of Array and String concepts of C programming language (K1, K2). CO4: Demonstrate the concept of function, pointers, and structure. (K3, K4, K5 (K2, K3,K4). CO5: Develop the uses of computers in the engineering industry. (K4,K5,K6) CO6: Discuss about the more advanced features of the C language (K3,K4,K6).	
7	Course Description	This course provides students with the statistical foundation of the various problems of real life. Students will learn to recognize the main features of the processes under investigation that could be analyzed in terms of advanced statistical approaches. Grading this course will help the future specialist to analyze the observed phenomena in advanced statistical level.	
8	**Outline syllabus**		**CO Mapping**
	Unit 1	**Lab. Experiment 1:**	
	A, B, C	Write a c program to swap two numbers with temporary variable. Write a c program to swap two numbers without temporary variable.	CO1, CO2
	Unit 2	**Lab. Experiment 2:**	
	A, B, C	Write a c Program to Add Two Integers. Write a program to	CO2, CO3

		check given year is leap year.	
	Unit 3	**Lab. Experiment 3:**	
	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, CO4
	Unit 4	**Lab. Experiment 4:**	
	A, B, C	Write a function to calculate the factorial of a number. Write a c program to store information about student using the structure.	CO4, CO5, CO6
	Unit 5	**Lab. Experiment 5:**	
	A, B, C	Write a c program to store information of a student using union. Write a c program to swap two values using pointers.	CO5, CO6
	Mode of examination	Practical+Viva	
	Weightage Distribution	CA:25%; CE:25%; ESE:50%	
	Text book/s*	1. Yashavant Kanetkar, “Let Us C”, BPB.	
	Other References	1. Byron Gottfried, “Programming with C”, TMH.	

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**
BDA359.1	1	2	2	2		1	1	3	1		2	1	2	
BDA359.2	1	2	3	2		1	1	3	1		2	1	2	
BDA359.3	1	2	2	2		1	1	3	1		2	1	2	
BDA359.4	1	2	2	2		1	1	3	1		2	1	2	
BDA359.5	1	2	2	2		1	1	3	1		2	1	2	
BDA359.6	1	2	2	2		1	1	3	1		2	1	2	
Average	**1.0**	**2.0**	**2.0**	**2.0**		**1.0**	**1.0**	**3.0**	**1.0**		**2.0**	**1.0**	**2.0**	

School: SSBSR		**Batch: 2023-27**	
Programme: B.Sc. (Hons.)		**Academic Year: 2026-27**	
Branch: Mathematics		**Semester: VII**	
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%; ESE:75%	
	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					3		3	
MDA110.2	2	3	3	2		1					3		3	
MDA110.3	2	2	2	3		1					3		3	
MDA110.4	2	3	2	2		1					3		3	
MDA110.5	3	3	2	2		1					3		3	
MDA110.6	3	3	2	3		1					3		3	
Average	**2.3**	**2.6**	**2.0**	**2.1**		**1.0**					**3.0**		**3.0**	

School: SSBSR		**Batch: 2023-27**	
Programme: B.Sc. (Hons.)		**Academic Year: 2026-27**	
Branch: Mathematics		**Semester: VII**	
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	CO2

		data's trend by the method of the freehand curve, Moving average curve, semi-average curve, and least square method.	
	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:25%; CE:25%; ESE:50%	
	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	**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**
CO														
MDA155.1				2	1	1	1	3	1	1	3	1	2	
MDA155.2				2	1	1	1	3	1	1	3	1	2	
MDA155.3				2	1	1	1	3	1	1	3	1	2	
MDA155.4				2	1	1	1	3	1	1	3	1	2	
MDA155.5				2	1	1	1	3	1	1	3	1	2	
MDA155.6				2	1	1	1	3	1	1	3	1	2	
Average				**2.0**	**1.0**	**1.0**	**1.0**	**3.0**	**1.0**	**1.0**	**3.0**	**1.0**	**2.0**	

School: SSBSR		**Batch: 2023-27**	
Programme: B.Sc. (Hons.)		**Academic Year: 2026-27**	
Branch: Mathematics		**Semester: VII**	
1	Course Code	**MDA111**	
2	Course Title	**Non-Parametric Statistical Inference**	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
	Course Status	DSE	
5	Course Objective	Familiarise students with basic concepts of non-parametric inference, nonparametric estimation, order statistics use, and application in real-life data.	
6	Course Outcomes	CO1: Explain the concept of non-parametric inference. (K2, K4) CO2: Apply the concept of nonparametric estimation and explain the completeness of the order statistic. (K3) CO3: Explain and use different non-parametric test estimators. (K2, K3, K4) CO4: Explain the properties of non-parametric test estimators.(K2, K4) CO5: Describe the concept of order statistics. (K1, K2) CO6: Understand and evaluate the application of non-parametric inference on real-life data. (K2, K6)	
7	Course Description	This course will cover the basic concepts of non-parametric inference, nonparametric estimation, order statistics use, and application in real-life data	
8			
	Unit 1		
	A	Non-Parametric methods, Advantages and Disadvantages,	CO1
	B	Uses and application of the non-parametric method,	CO1
	C	Type of non-parametric test,	CO1
	Unit 2		
	A	The sign test for paired data, One sample sign test,	CO2
	B	Ranked sum test, Mann-Whitney U test,	CO2
	C	Kruskalwali’s test or H test,	CO2
	Unit 3		
	A	One sample run test, median test for randomness,	CO3
	B	Runs above and below the median, spearman rank correlation test	CO3, CO4
	C	Testing of hypothesis about rank correlation,	CO4
	Unit 4		
	A	Kolmogrov Smirnov test, Kendall test of Concordance	CO5
	B	Median test for two independent samples,	CO5
	C	Wilcoxon Signed rank test, The Matched pairs sign, test	CO5
	Unit 5		
	A	Introduction and application of order statistics, Distribution of Single Order Statistics,	CO6
	B	Joint distribution of two or more order statistics, Distribution of difference of two distinct order statistics.	CO6
	C	Distribution of Range, Distribution of Quartile, and Distribution of median.	CO6
	Mode of examination	Theory	
	Weightage Distribution	CA:25%; ESE:75%	

	Text book/s*	1. Gibbons, J.D. & Chakraborti, S. (2010). Nonparametric Statistical Inference, 5th Edition. CRC Press.	
	Other References	1. Bonnini, S., Corain, L., Marozzi, M. & Salmaso, L. (2014). Nonparametric Hypothesis Testing Rank and Permutation Methods with Applications in R. Wiley.	

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
MDA111.1	3	3	2	2	-	1	-	-	-	-	3	-	3	-
MDA111.2	2	3	3	2	-	1	-	-	-	-	3	-	3	-
MDA111.3	2	2	2	3	-	1	-	-	-	-	3	-	3	-
MDA111.4	2	3	2	2	-	1	-	-	-	-	3	-	3	-
MDA111.5	3	3	2	2	-	1	-	-	-	-	3	-	3	-
MDA111.6	3	3	2	3	-	1	-	-	-	-	3	-	3	-
Average	**2.3**	**2.6**	**2.0**	**2.1**	**-**	**1.0**	**-**	**-**	**-**	**-**	**3.0**	**-**	**3.0**	**-**

School: SSBSR		**Batch: 2023-27**	
Programme: B.Sc. (Hons.)		**Academic Year: 2026-27**	
Branch: Mathematics		**Semester: VII**	
1	Course Code	**MDA112**	
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%; ESE:75%	
	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**
MDA112.1	2	2	1	2	-	1	-	3	-	-	3	1	1	-
MDA112.2	2	2	1	2	-	1	-	3	-	-	3	1	1	-
MDA112.3	2	2	1	2	-	1	-	3	-	-	3	1	1	-
MDA112.4	2	2	1	2	-	1	-	3	-	-	3	1	1	-
MDA112.5	2	2	1	2	-	1	-	3	-	-	3	1	1	-
MDA112.6	2	2	1	2	-	1	-	3	-	-	3	1	1	-
Average	**2.0**	**2.0**	**1.0**	**2.0**	**-**	**1.0**	**-**	**3.0**	**-**	**-**	**3.0**	**1.0**	**1.0**	**-**

School: SSBSR		**Batch: 2023-27**	
Programme: B.Sc. (Hons.)		**Academic Year: 2026-27**	
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	DSE	
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:25%; CE:25%; ESE:50%	
	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	3	2	2	2	-	1	1	3	1	-	3	1	2	-
MDA156.2	3	2	3	2	-	1	1	3	1	-	3	1	2	-
MDA156.3	3	2	2	2	-	1	1	3	1	-	3	1	2	-
MDA156.4	3	2	2	2	-	1	1	3	1	-	3	1	2	-
MDA156.5	3	2	2	2	-	1	1	3	1	-	3	1	2	-
MDA156.6	3	2	2	2	-	1	1	3	1	-	3	1	2	-
Average	**3.0**	**2.0**	**2.0**	**2.0**	**-**	**1.0**	**1.0**	**3.0**	**1.0**	**-**	**3.0**	**1.0**	**2.0**	**-**

School: SSBSR		**Batch: 2023-27**	
Programme: B.Sc. (Hons.)		**Academic Year: 2026-27**	
Branch: Mathematics		**Semester: VII**	
1	Course Code	**MDA113**	
2	Course Title	**Survival Analysis**	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
	Course Status	DSE	
5	Course Objective	To demonstrate and intended to verse students in the techniques necessary to understand and carry out methods of research in survival analysis.	
6	Course Outcomes	CO1: Explain the concept of survival data, and the roles played by censoring, and survival and hazard functions. CO2: Format data appropriately for analysis, and understanding. CO3: Apply and drew the graph of survival data, and the Kaplan – Meier curve. CO4: Explain the concept ofKernel smoothed distribution estimator and kernel smoothed hazard rate estimator CO5: Describe how to fit the Cox Proportional Hazards model. CO6: Apply models to the data analysis using the Cox proportional hazards model.	
7	Course Description	A UG-level course in survival analysis, intended to verse students in the techniques necessary to understand and carry out methods of research in survival analysis. Lectures study the large-sample properties of estimators based on one-sample, k-sample and partial likelihood inference, with proofs based on counting process and Martingale theory. The theory of competing risks is studied from several angles. Many extensions of the Cox model to more complex data structures are considered.	
8	**Outline syllabus**		**CO Mapping**
	Unit 1		
	A	Basic quantities. The survival functions. The hazard functions. The mean residual life time function and median life.	CO1
	B	Common parametric models for survival data. Models for competing risks.	CO1, CO2
	C	Right censoring. Left or interval censoring. Truncation. Likelihood construction for censored and truncated data. Basic ideas for counting processes and martingales.	CO1, CO2
	Unit 2		
	A	Nonparametric estimators of the survival and cumulative hazard functions. Kaplan-Meier estimator and Nelson-Allen estimator.	CO3
	B	Point wise confidence intervals for the survival and cumulative	CO3

		hazard functions.	
	C	Confidence bands for the survival function. Point and interval estimates of the mean and median survival time, and quintiles.	CO3
	Unit 3		
	A	Estimators of the survival function for left-truncated and right-censored data. Summary curves for competing risks.	CO2
	B	Estimating the survival function for left, double and interval censoring.	CO2
	C	Estimation of the survival functions for right-truncated data. Estimation in the cohort life table or grouped data.	CO2
	Unit 4		
	A	Kernel smoothed distribution estimator and kernel smoothed hazard rate estimator.	CO4
	B	Hypothesis testing. One-sample tests. Tests for two samples and more than two samples. Tests for trend. Stratified log-rank test.	CO4
	C	Parametric models with covariates. The accelerated failure time (AFT) model. Some popular AFT models. Diagnostic methods for parametric models.	CO4
	Unit 5		
	A	The Cox proportional hazards model. Partial likelihoods for distinct-event time data.	CO5, CO6
	B	Partial likelihood when ties are present. Local tests. Estimation of the survival function.	CO5, CO6
	C	Additional materials: Model building and high-dimensional data analysis using the Cox proportional hazards model.	CO5, CO6
	Mode of examination	Theory	
	Weightage Distribution	CA:25%; ESE:75%	
	Text book/s*	1. Lee, E. T. and Wang, J. W. (2003).Statistical Methods for Survival Data Analysis, 3rdEdition. John Wiley.	
	Other References	1. Liu, X. (2012). Survival Analysis: Models and Applications, Wiley, New York.	

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
MDA113.1	1	2	1	2	-	1	-	3	-	-	3	-	1	-
MDA113.2	1	2	1	2	-	1	-	3	-	-	3	-	1	-
MDA113.3	1	2	1	2	-	1	-	3	-	-	3	-	1	-
MDA113.4	1	2	1	2	-	1	-	3	-	-	3	-	1	-
MDA113.5	1	2	1	2	-	1	-	3	-	-	3	-	1	-
MDA113.6	1	2	1	2	-	1	-	3	-	-	3	-	1	-
Average	**1.0**	**2.0**	**1.0**	**2.0**	**-**	**1.0**	**-**	**3.0**	**-**	**-**	**3.0**	**-**	**1.0**	**-**

Programme: B.Sc. (Hons.)		**Academic Year: 2026-27**	
Branch: Mathematics		**Semester: VIII**	
1	Course Code	**MDA115**	
2	Course Title	**Demography**	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
	Course Status	DSE	
5	Course Objective	The course tends to develop a basic understanding of demographic theory and its application to various aspects of the economy. The course will also help in presenting an economic argument and develop analytical abilities of different demographic concepts in quantitative terms.	
6	Course Outcomes	CO1: Gain a sound command over the basic tenets of demography as well as key demographic issues and illustrations in the context of a large and diverse country like India. CO2: Grasp a clear understanding of the inter-relationship between demography and the process of economic development. CO3: Comprehend the basic components of population (fertility, mortality, migration) CO4: To study established theories of population CO5: To explore various aspects of the population policy and to study its impact on socio economic issues	
7	Course Description	This course provides an introduction to demography and population studies	
8			
	Unit 1	**Introduction**	
	A	Demography- Its definition, nature and scope, its relation with other disciplines.	CO1
	B	Theories of population-Malthusian Theory, Optimum theory of population and theory of Demographic Transition.	CO1
	C	Population growth in India, Features of Indian Population.	CO1
	Unit 2	**Sources of Demographic data in India**	
	A	Salient features of census- including 2011 census, Civil Registration System.	CO2
	B	National Sample Survey	CO2
	C	Demographic Survey- National Family Health Survey – 1, 2 and 3 Relative merits and demerits of these sources.	CO2
	Unit 3	**Techniques of Analysis**	
	A	Crude birth rate and death rate, Age specific birth rate and death rate, standardized birth rate and death rate.	CO3
	B	Study of fertility- Total Fertility Rate, Gross Reproduction Rate and Net Reproduction Rate	CO3

	C	Measurement of Population Growth rate- Simple Growth Rate and Compound Growth Rate.	CO3
	Unit 4	**Modals of Demography& Life table**	
	A	Logistic Models, Measures of Morbidity, Mortality graduation	CO4
	B	Methods of Construction of Abridged life Tables and its Applications.	CO4
	C	Population Estimates and Projection.	CO4
	Unit 5	**Vital Statistics**	
	A	Vital Statistics: Historical background, Civil Registration System in India: history, coverage, problems of civil registration, Sample Registration System (SRS), advantages and limitations.	CO5
	B	Population Surveys: Meaning, Scope, uses, limitations; Major surveys: National Sample Surveys (NSS), World Fertility Survey (WFS).	CO5
	C	Demographic Health Surveys (DHS), Reproductive and Child Health Survey (RCHS). National Family Health Surveys (NFHS), Comprehensive Nutrition Survey; Aging survey	CO6
	Mode of examination	Theory	
	Weightage Distribution	CA:25%; ESE:75%	
	Text book/s*	1. Bhende A.A. and Tara Kanitkar(1982)- 'Principles of Population Studies'- Himalaya Publishing House, Bombay	
	Other References	1. Srinivasan K (1998) – 'Basic Demographic Techniques and Applications' – Sage Publications, New Delhi.	

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
MDA115.1	2	2	1	2	-	1	-	3	-	-	3	3	3	-
MDA115.2	2	2	1	2	-	1	-	3	-	-	3	3	3	-
MDA115.3	2	2	1	2	-	1	-	3	-	-	3	3	3	-
MDA115.4	2	2	1	2	-	1	-	3	-	-	3	3	3	-
MDA115.5	2	2	1	2	-	1	-	3	-	-	3	3	3	-
MDA115.6	2	2	1	2	-	1	-	3	-	-	3	3	3	-
Average	**2.0**	**2.0**	**1.0**	**2.0**	**-**	**1.0**	**-**	**3.0**	**-**	**-**	**3.0**	**3.0**	**3.0**	**-**

School: SSBSR		**Batch: 2023-27**	
Programme: B.Sc. (Hons.)		**Academic Year: 2026-27**	
Branch: Mathematics		**Semester: VIII**	
1	Course Code	**MDA116**	
2	Course Title	**Statistical Quality Control**	
3	Credits	4	
4	Contact Hours(L-T-P)	4-0-0	
	Course Status	DSE	
5	Course Objective	The course tends to a comprehensive coverage of modern quality control techniques to include the design of statistical process control systems, acceptance sampling, and process improvement.	
6	Course Outcomes	CO1:Acquire knowledge and develop analysis skills on industrial experimentation. CO2: Acquire knowledge on acceptance sampling principles and methods. CO3: Develop skills to analyse quality related data using advanced statistical methods. CO4: Acquire knowledge on the traditional statistical quality control methods and develop charting techniques. CO5: Become familiar with the advanced statistical quality control methods. CO6: Develop new empirical approaches to quality related problems.	
7	Course Description	This course provides an introduction to Statistical Quality Control.	
8			
	Unit 1	**Introduction of Quality Control**	
	A	Quality: Definition Its concept, application and importance. Introduction to Process and Product Controls.	CO1
	B	Seven tools of SPC, chance and assignable Causes of quality variation. Statistical Control Charts.	CO1
	C	Construction and Statistical basis of 3-σ Control charts, Rational Sub-grouping.	CO1
	Unit 2	**Control Charts**	
	A	Control charts for variables: X-bar & R-chart, X-bar & s-chart.	CO2
	B	Control charts for attributes: np-chart, p-chart, c-chart and u-chart.	CO2
	C	Comparison between control charts for variables and control charts for attributes. Analysis of patterns on control chart, estimation of process capability.	CO2
	Unit 3	**Techniques of Analysis**	

	A	Crude birth rate and death rate, Age specific birth rate and death rate, standardized birth rate and death rate.	CO3
	B	Single and Double sampling plan their OC, AQL, LTPD, AOQ, AOQL, ASN, ATI functions with graphical interpretation.	CO3
	C	Use and interpretation of Dodge and Romig's sampling inspection plan tables.	CO3
	Unit 4	**Index Number**	
	A	Index Numbers: Definition, construction of index numbers.	CO4
	B	Problems thereof for weighted and unweighted index numbers including Laspeyre's, Paasche's, Edgeworth-Marshall and Fisher's.	CO4
	C	Chain index numbers, conversion of fixed based to chain-based index numbers and vice-versa.	CO4
	Unit 5	**Consumer price index numbers**	
	A	Consumer price index numbers.	CO5
	B	Compilation of indices, base shifting, splicing and deflating of index numbers.	CO5
	C	Index of industrial and agriculture production, usage and limitations of index numbers.	CO6
	Mode of examination	Theory	
	Weightage Distribution	CA:25%; ESE:75%	
	Text book/s*	1. Montgomery, Douglas, C, Introduction to Statistical Quality Control, John Wiley & Sons.	
	Other References	1. Eugene Lodewick Grant, Richard S. Leavenworth, Statistical Quality Control, 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**
MDA116.1	-	2	1	2	-	1	-	3	-	-	3	3	3	-
MDA116.2	-	2	1	2	-	1	-	3	-	-	3	3	3	-
MDA116.3	-	2	1	2	-	1	-	3	-	-	3	3	3	-
MDA116.4	-	2	1	2	-	1	-	3	-	-	3	3	3	-
MDA116.5	-	2	1	2	-	1	-	3	-	-	3	3	3	-
MDA116.6	-	2	1	2	-	1	-	3	-	-	3	3	3	-
Average	**-**	**2.0**	**1.0**	**2.0**	**-**	**1.0**	**-**	**3.0**	**-**	**-**	**3.0**	**3.0**	**3.0**	**-**