Programme and Course Structure

Sharda School of Basic Sciences & Research
Department of Mathematics

B.Sc. (Hons./Hons. With Research)
Data Science & Analytics

Programme Code: SBR0308

Batch 2024-28

Vision, Mission and Core Values of the University

Vision of the University

To serve the society by being a global University of higher learning in pursuit 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.

Core Values

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

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.

Core Values

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

B. Sc. (Hons./Hons. With Research) Data Science & Analytics

Programme Educational Objectives (PEOs)

PEO1: Prepare professionals conversant with current and advanced technological tools to carry out Investigation, analysis and synthesis by identifying various compute oriented solutions.

PEO2: To develop positive attitude and skills which enable them to become a multi facet personality.

PEO3: To prepare students in such a way so that they perform excellently in national label entrance examinations conducted by various well known institution like IIT's/ central Universities/other academic institutes etc. to pursue their PG/MS/Dual PG and Ph.D. programs.

PEO4: To make them aware of effective machine learning and Artificial Intelligence based data analytics and inference required for Industrial Application.

PEO5: To inculcate passion for lifelong learning by introducing principles of group dynamics, public policies, environmental and societal context.

Programme Outcomes (POs)

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) Data Science & Analytics

PSO1. Demonstrate proficiency with statistical analysis of data using advanced application tools.

PSO2. Apply data science concepts and methods to solve problems in real-world contexts.

PSO3. Estimate predictions for a given complex problem using data analytical methods not limited to machine learning and deep learning concepts.

Mapping of PEOs with Mission Statements

PEO Statements	School Mission1	School Mission2	School Mission3	School Mission4	School Mission5	School Mission6
PEO1	3	2	3	1	2	3
PEO2	3	2	3	1	2	3
PEO3	3	3	3	3	3	3
PEO4	3	2	3	1	3	3
PEO5	3	2	2	3	2	3

Mapping of Programme Outcomes Vs Programme Educational Objectives

	PEO1	PEO2	PEO3	PEO4	PEO5
PO1	3	3	3	2	1
PO2	3	3	3	2	1
PO3	3	3	3	2	1
PO4	3	2	3	2	1
PO5	2	3	2	3	2
PO6	3	3	3	2	2
PO7	1	2	1	3	1
PO8	2	2	1	3	2
PO9	2	2	2	3	2
PO10	2	2	2	3	3
PO11	2	3	3	2	1
PSO1	2	1	1	2	1
PSO2	2	2	2	2	1
PSO3	3	3	3	2	1

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

4-Year Course Structure of B. Sc. (Hons./Hons. With Research) Data Science & Analytics

Department of Mathematics

		Subject 1	Subject 2	Subject 3		Subject 4	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 (4+1)	X	Stats (3)	X	CS (3+1)	SEC (3)	SK (2)	VAC (3)	{40}	**{40}** **Certificate in Faculty**
	II	Maths (4+1)	CS (3+1)	X	X	Stats (3)	SEC (3)	SK (2)	VAC (3)		
2	III	Stats (4+1)	CS (3+1)	Maths (4)	**RBL-1** (Audit)**	Maths (3)	SEC (3)	SK (2)	X	{40}	**{80}** **Diploma in Faculty**
	IV	CS (3+1)	CS (4+1)	Stats (4+1)	**RBL-2** (Audit)**	OPE-1(3)	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"

^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.

3	V	CS (5) CS (4+1)	Stats (3+1)	Stats (2+1)	**RBL-3 (1)**	X	X	X	Industry Connect (2)	{40}	**{120}** **Bachelor Degree inFaculty**
	VI	Maths (4+1) Stats (4+1)	Stats (3+1)	X	**RBL-4 (1)**	CS (3)	X	X	Community Connect (2)		
4	VII	CS (4) CS (4)	X	Stats (3+1) Stats (4)	X	OPE-2 (4)	X	X	X	{40}	**{160}** **Bachelor (Hons.) in Faculty**
	VIII	CS (4) CS (4) Stats (4)	X	Stats (4)	X	OPE-3 (4)	X	X	X		
4	VII	CS (4) CS (4) Stats (3+1) Stats (4)	X	X	X	OPE-2 (4)	X	X	Dissertation-1 (3)	{40}	**{160}** **Bachelor (Hons. With Research) in Faculty**
	VIII	CS/Stats (4)	X	X	X	OPE-3 (4)	X	X	Dissertation-2 (9)		

^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 Template
B. Sc. (Hons./Hons. With Research) Data Science & Analytics **Batch: 2024-28**
Term: 2401 (Semester-I)

S. No.	Course Code	Course Name	Teaching Load				Credits	Pre-Requisite/ Co-Requisite	Type of Course: 1. CC; 2. DSE; 3. OPE; 4. SEC; 5. AEC; 6. VAC; 7. Project
	THEORY		**L**	**T**	**P**	**TOTAL (hrs)**			
1.	MSM101	Foundation Course in Mathematics	4	0	0	4	4	Basic Mathematics 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.	VAC103	Environmental Management	3	0	0	3	3		VAC
	PRACTICALS								
5.	ARP101	Communicative English-1	1	0	2	3	2		AEC
6.	VOM103	Essential Excel Skills for Business	0	0	6	6	3		SEC
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 Template
B. Sc. (Hons./Hons. With Research) Data Science & Analytics **Batch: 2024-28**
TERM: 2402 (Semester-II)

S. No.	Course Code	Course Name	Teaching Load				Credits	Pre-Requisite/ Co-Requisite	Type of Course: 1. CC; 2. DSE; 3. OPE; 4. SEC; 5. AEC; 6. VAC; 7.Project
	THEORY		**L**	**T**	**P**	**TOTAL (hrs)**			
1.	CMS131	Matrix Analysis and Linear Algebra	4	0	0	4	4	Pre-requisite MSM101	CC
2.	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
	PRACTICALS								
4.	ARP102	Communicative English-2	1	0	2	3	2	Pre-requisite ARP101	AEC
5.	VOM104	Advanced Excel Skills for Business	0	0	6	6	3	Pre-requisite VOM103	SEC
6.	VAC110	Yoga for Holistic Health	0	1	4	5	3		VAC
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 Template
B. Sc. (Hons./Hons. With Research) Data Science & Analytics **Batch: 2024-28**
TERM: 2501 (Semester-III)

S. No.	Course Code	Course Name	Teaching Load				Credits	Pre-Requisite/ Co-Requisite	Type of Course: 1. CC; 2. DSE; 3. OPE; 4. SEC; 5. AEC; 6. VAC; 7.Project
	THEORY		**L**	**T**	**P**	**TOTAL (hrs)**			
1.	MSM312	Discrete Mathematics	3	1	0	4	4	Pre-requisite MSM101	DSE
2.	BDA215	Operations Research	3	0	0	3	3	Pre-requisite MSM101	OPE
3.	BDA216	Statistical Inference	4	0	0	4	4	Pre-requisite CMS132	CC
4.	BDA217	Data Preparation and Data Cleaning	3	0	0	3	3	Pre-requisite CMS132	CC
	PRACTICALS								
5.	VOM203	Basic Excel Modelling	0	0	6	6	3	Pre-requisite VOM104	SEC
6.	ARP207	Logical Skill Building & Soft Skills	0	1	2	3	2	Pre-requisite ARP102	AEC
7.	BDA261	Statistical Inference Lab	0	0	2	2	1	Co-requisite BDA216	CC
8.	BDA262	Data Preparation and Data Cleaning Lab	0	0	2	2	1	Co-requisite BDA217	CC
9.	RBL001	Research Report Writing-I (RBL-1)	0	0	2	2	0	Pre-requisite ARP102	Project (Non-graded Qualifying)
TOTAL CREDITS							**21**		

Programme Structure Template
B. Sc. (Hons./Hons. With Research) Data Science & Analytics **Batch: 2024-28**
TERM: 2502 (Semester-IV)

S. No.	Course Code	Course Name	Teaching Load				Credits	Pre-Requisite/ Co-Requisite	Type of Course: 1. CC; 2. DSE; 3. OPE; 4. SEC; 5. AEC; 6. VAC; 7.Project
	THEORY		**L**	**T**	**P**	**TOTAL (hrs)**			
1.	BDA218	Data Ware Housing & Data Mining	3	0	0	3	3	Pre-requisite BDA217	CC
2.	BDA202	Database Management Systems	4	0	0	4	4	Pre-requisite MSM312	CC
3.	BDA214	Sampling Theory	4	0	0	4	4	Pre-requisite BDA216	DSE
4.	OPE	Open Elective-1	3	0	0	3	3		OPE
	PRACTICALS								
5.	ARP306	Campus to Corporate	0	1	2	3	2	Pre-requisite ARP207	AEC
6.	BDA270	Data Ware Housing & Data Mining Lab	0	0	2	2	1	Co-requisite BDA218	CC
7.	BDA271	Database Management Systems Lab	0	0	2	2	1	Co-requisite BDA202	CC
8.	BDA272	Sampling Theory Lab	0	0	2	2	1	Co-requisite BDA214	DSE
9.	RBL002	Research Based Learning-II (RBL-2)	0	0	2	2	0	Pre-requisite RBL001	Project (Non-graded Qualifying)
TOTAL CREDITS							**19**		

Programme Structure Template
B. Sc. (Hons./Hons. With Research) Data Science & Analytics **Batch: 2024-28**
TERM: 2601 (Semester-V)

S. No.	Course Code	Course Name	Teaching Load				Credits	Pre-Requisite/ Co-Requisite	Type of Course: 1. CC; 2. DSE; 3. OPE; 4. SEC; 5. AEC; 6. VAC; 7.Project
	THEORY		**L**	**T**	**P**	**TOTAL (hrs)**			
1.	BDA346	Artificial Intelligence	5	0	0	5	5	Pre-requisite BDA218	CC
2.	BDA303	Machine Learning	4	0	0	4	4	Pre-requisite BDA218	CC
3.	BDA319	Regression Analysis	3	0	0	3	3	Pre-requisite BDA214	CC
4.	BDA320/ BDA321	Advanced Statistical Analysis/ Experimental Design	2	0	0	2	2		DSE (Multi/Inter-discpli)
	PRACTICALS								
5.	BDA355	Machine learning Lab	0	0	2	2	1	Co-requisite BDA303	CC
6.	BDA356	Regression Analysis Lab	0	0	2	2	1	Co-requisite BDA319	CC
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
9.	BDA359/ BDA363	Advanced Statistical Analysis Lab/ Experimental Design Lab	0	0	2	2	1		DSE (Multi/Inter-discpli)
TOTAL CREDITS							**20**		

Programme Structure Template
B. Sc. (Hons./Hons. With Research) Data Science & Analytics **Batch: 2024-28**
TERM: 2602 (Semester-VI)

S. No.	Course Code	Course Name	Teaching Load				Credits	Pre-Requisite/ Co-Requisite	Type of Course: 1. CC; 2. DSE; 3. 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 CMS131	CC
2.	BDA322	Statistical Simulation	4	0	0	4	4	Pre-requisite BDA319	CC
3.	BDA323	Multivariate Data Analysis	3	0	0	3	3	Pre-requisite BDA319	CC
4.	BDA325	Deep Learning	3	0	0	3	3	Pre-requisite BDA303	OPE
	PRACTICALS								
5.	CMS371	Numerical Methods Lab	0	0	2	2	1	Co-requisite CMS331	CC
6.	BDA360	Statistical Simulation Lab	0	0	2	2	1	Co-requisite BDA322	CC
7.	BDA361	Multivariate Data Analysis Lab	0	0	2	2	1	Co-requisite BDA323	CC
8.	CCU108	Community Connect	0	0	4	4	2		Project (Multi/Inter-discpli)
9.	RBL004	Research Based Learning-IV (RBL-4)	0	0	2	2	1	Pre-requisite RBL003	Project
TOTAL CREDITS							**20**		

Programme Structure Template
B. Sc. (Hons./Hons. With Research) Data Science & Analytics **Batch: 2024-28**
TERM: 2701 (Semester-VII)

S. No.	Course Code	Course Name	Teaching Load				Credits	Pre-Requisite/ Co-Requisite	Type of Course: 1. CC; 2. DSE; 3. OPE; 4. SEC; 5. AEC; 6. VAC; 7.Project
	THEORY		**L**	**T**	**P**	**TOTAL (hrs)**			
1.	MDA104	Next Generation Databases	4	0	0	4	4	Pre-requisite BDA346, 303, 323	CC
2.	MDA109	Big Data Analytics	4	0	0	4	4	Pre-requisite BDA323	CC
3.	MDA110/ MDA112	Time Series, Forecasting and Index Number/ Econometrics	3	0	0	3	3		DSE/CC*
4.	MDA111/ MDA113	Non-Parametric Statistical Inference/ Survival Analysis	4	0	0	4	4		DSE/CC*
5.	OPE	Open Elective-1	4	0	0	4	4		OPE
	PRACTICALS								
6.	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. Data Science & Analytics 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) Data Science & Analytics.**

Programme Structure Template
B. Sc. (Hons./Hons. With Research) Data Science & Analytics **Batch: 2024-28**
TERM: 2702 (Semester-VIII)

S. No.	Course Code	Course Name	Teaching Load				Credits	Pre-Requisite/ Co-Requisite	Type of Course: 1. CC; 2. DSE; 3. OPE; 4. SEC; 5. AEC; 6. VAC; 7.Project
	THEORY		**L**	**T**	**P**	**TOTAL (hrs)**			
1.	MDA107	Advanced Big Data and Text Analytics	4	0	0	4	4	Pre-requisite MDA109	CC
2.	MDA114	Bayesian Data Analysis	4	0	0	4	4	Pre-requisite BDA322, 323	CC
3.	MDA117	Computational Intelligence	4	0	0	4	4	Pre-requisite BDA303,322,346,	CC
4.	MDA115/ MDA116	Demography/ Statistical Quality Control	4	0	0	4	4		DSE/CC*
5.	OPE	Open Elective-2	4	0	0	4	4		OPE
TOTAL CREDITS							**20**		

***Credited Research Project/Dissertation:** Students of B.Sc. Data Science & Analytics 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) Data Science & Analytics.**

B. Sc. (Hons./Hons. With Research) Data Science & Analytics 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	3	4	3	2	0	0	3	8	4
4	9	5	4	0	2	0	0	0	9	9
5	14	3	0	0	0	0	3	0	10	7
6	17	0	0	0	0	0	3	5	3	9
Total:	60	15	16	9	8	6	6	16	38	37
%	**50**	**12.5**	**13.33**	**7.5**	**6.67**	**5**	**5**	**13.33**	**31.67**	**30.83**
7	8	8	4	0	0	0	0	0	8	8
8	12	4	4	0	0	0	0	0	3	13
Total:	80	27	24	9	8	6	6	16	49	58
%	**50**	**16.88**	**15**	**5.63**	**5**	**3.75**	**3.75**	**10**	**30.63**	**36.25**

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	2.3	2.6	2.0	2.1		1.0					1.0			
CMS102	2.3	2.6	2.0	2.1		1.0					1.0	1.0		
CSE113	2.3	2.6	2.0	2.1		1.0					1.0			
VOM103		2.0	1.0	2.0		1.0		3.0			1.0	1.0	1.0	
ARP101	1.0	2.0	2.0	2.0		1.0	1.0	3.0	1.0		1.0			
VAC103	1.0	2.0	2.0	2.0		1.0	1.0	3.0	1.0		2.0			
CMS151	1.0	2.0	2.0	2.0		1.0	1.0	3.0	1.0		1.0	1.0		
CSP113	1.0	2.0	2.0	2.0		1.0	1.0	3.0	1.0		2.0	1.0		
CMS131	2.5	2.5	2.5	2.6		1.0					1.0		1.0	
CMS132	2.3	2.6	2.0	2.1		1.0					1.0	1.0	1.0	
CSE242	2.3	2.6	2.0	2.1		1.0					1.0			
VOM104	2.0	1.0	2.0		1.0		3.0					1.0	1.0	
ARP102	1.0	2.0	2.0	2.0		1.0	1.0	3.0	1.0					
VAC110	2.0			1.0	1.0		2.0	2.0	1.0					
CMS171	3.0	2.2	2.7	2.7	2.5	2.5	3.0	2.3	2.0	1.0	1.0	2.0	1.0	
CSP242	1.0	2.0	2.0	2.0		1.0	1.0	3.0	1.0		1.0			
MSM312	2.6	2.0	2.1		1.0					1.0				
BDA215	1.0	2.0	2.3	2.1	1.0	1.0	1.0	2.0	3.0		1.0			1.0
BDA216	2.3	2.6	2.0	2.1		1.0					1.0	1.0	1.0	1.0
RBL001	2.3	2.6	2.0	2.1	1.0	1.0					2.0	1.0		
BDA217	2.0	1.0	2.0		1.0		3.0			2.0		1.0	1.0	
VOM203	2.0	1.0	2.0		1.0	2.0	3.0	2.0		2.0			1.0	
ARP207	2.0	2.0	1.0	3.0	1.0	3.0	1.0							
BDA261	1.0	2.0	2.0	2.0		1.0	1.0	3.0	1.0		1.0	1.0	2.0	
BDA262	1.0	2.0	2.0	2.0	1.0	1.0	1.0	3.0	1.0	1.0	3.0	1.0	2.0	3.0
BDA218	2.3	2.6	2.0	2.1		1.0					1.0	1.0		
BDA202	2.3	2.6	2.0	2.1		1.0					1.0	1.0		
BDA214	2.3	2.6	2.0	2.1		1.0					1.0	1.0	1.0	
RBL002	2.3	2.6	2.0	2.1	1.0	1.0					1.0	1.0		
ARP306			2.0	2.0		3.0	1.0	3.0	1.0		2.0			
BDA270	1.0	2.0	2.0	2.0	2.0	1.0	1.0	3.0	1.0	1.0	2.0	1.0	2.0	2.0
BDA271	1.0	2.0	2.0	2.0		1.0	1.0	3.0	1.0		2.0		2.0	
BDA272	1.0	2.0	2.0	2.0	1.0	1.0	1.0	3.0	1.0		2.0	1.0		
BDA346	2.3	2.6	2.0	2.1		1.0					3.0	3.0		
BDA303	2.3	2.6	2.0	2.1		1.0					3.0	3.0		
BDA319	2.3	2.6	2.0	2.1	1.0	1.0					3.0	3.0		
BDA320		2.0	1.0	2.0		1.0		3.0			3.0	3.0	1.0	
BDA321		2.0	1.0	2.0		1.0		3.0			1.0	1.0		
RBL003		2.0	1.0	2.0	2.0	1.0		3.0			2.0	2.0	2.0	2.0
INC001	2.0	1.0	2.0	2.0	1.0	2.0	3.0	2.0	2.0	2.0	2.0	2.0	2.0	

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
BDA355	1.0	2.0	2.0	2.0	2.0	1.0	1.0	3.0	1.0	2.0	3.0	2.0	2.0	3.0
BDA356	1.0	2.0	2.0	2.0	2.0	1.0	1.0	3.0	1.0	2.0	2.0	2.0	2.0	3.0
BDA357	1.0	2.0	2.0	2.0	1.0	1.0	1.0	3.0	1.0	1.0	3.0	1.0	2.0	3.0
CMS331	2.5	2.5	2.5	2.6	2.0	1.0					2.0			
BDA322	2.3	2.6	2.0	2.1	2.0	1.0					2.0	2.0		
BDA323	2.3	2.6	2.0	2.1	2.0	1.0					2.0	2.0		
RBL004				2.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	1.0	1.0
BDA324		2.0	1.0	2.0		1.0		3.0			3.0	3.0		
CCU108	1.0	2.0	2.0	3.0	3.0	2.0	3.0	3.0	3.0	2.0	1.0	2.0	2.0	3.0
CMS371	2.2	3.0	2.2	2.7	2.7	2.5	2.5	2.5	2.3	2.0	2.0		1.0	
BDA360	1.0	2.0	2.0	2.0		1.0	1.0	3.0	1.0		3.0	1.0	2.0	3.0
BDA361	1.0	2.0	2.0	2.0		1.0	1.0	3.0	1.0		3.0	1.0	2.0	3.0
MDA104	2.3	2.6	2.0	2.1		1.0					3.0		3.0	
MDA109	2.3	2.6	2.0	2.1		1.0					3.0		3.0	
MDA110	2.3	2.6	2.0	2.1		1.0					3.0		3.0	
MDA111	2.3	2.6	2.0	2.1		1.0					3.0		3.0	
MDA112		2.0	1.0	2.0		1.0		3.0			3.0	1.0	1.0	1.0
MDA113		2.0	1.0	2.0		1.0		3.0			3.0		1.0	1.0
MDA155				2.0	1.0	1.0	1.0	3.0	1.0	1.0	3.0	1.0	2.0	3.0
MDA156	1.0	2.0	2.0	2.0		1.0	1.0	3.0	1.0		3.0	1.0	2.0	3.0
MDA107	2.3	2.6	2.0	2.1		1.0					3.0			
MDA114		2.0	1.0	2.0		1.0		3.0			3.0		1.0	1.0
MDA117		2.0	1.0	2.0		1.0		3.0			3.0		1.0	1.0
MDA115		2.0	1.0	2.0		1.0		3.0			3.0	3.0	3.0	
MDA116		2.0	1.0	2.0		1.0		3.0			3.0	3.0	3.0	

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

Detailed Syllabus for

CERTIFICATE COURSE IN

APPLIED MATHEMATICS

School: SSBSR		**Batch: 2024-28**	
Programme: B.Sc. (Hons.)		**Academic Year: 2024-25**	
Branch: Data Science & Analytics		**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 familiarise 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 the 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 the 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. 2. Jain, M.K., and Iyengar, S.R.K., "Advanced Engineering Mathematics", Narosa Publications	
	Other References	1. Thomas, B.G., and Finny R.L., "Calculus and Analytical geometry", Pearson Education Asia, AdisonWisley. 2. Simmons, G.F., "Differential Equations with applications with applications", Tata 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
MSM101.1	3	3	2	2		1					1			
MSM101.2	2	3	3	2		1					1			
MSM101.3	2	2	2	3		1					1			
MSM101.4	2	3	2	2		1					1			
MSM101.5	3	3	2	2		1					1			
MSM101.6	3	3	2	3		1					1			
Average	**2.3**	**2.6**	**2.0**	**2.1**		**1.0**					**1.0**			

School: SSBSR		**Batch: 2024-28**	
Programme: B.Sc. (Hons.)		**Academic Year: 2024-25**	
Branch: Data Science & Analytics		**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, logic and analytical tools, analyze and communicatequantitative data verbally, graphically, symbolically, and numerically. 2. To make students familiar with the concept of Probability and Statistics and display data utilizingvarious tables, charts, and graphs.	
6	Course Outcomes	CO1: Describe the process and particular steps in designing studies, collecting and analyzing data, interpreting and presenting results; and developing 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 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, 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, and develop the ability to use formal mathematical argument in the context of probability. (K2, K5) CO6: Develop the skills to interpret the results of statistical analysis. (K2, K5).	
7	Course Description	This is an introductory course in statistics. Students are introduced to the fundamental concepts involved in using sample data to make inferences about populations. Included are the study of measures of central tendency and dispersion, finite probability, statistical inferences from large and small samples, linear regression, and correlation.	
8	**Outline syllabus**		**CO Mapping**
	Unit 1	**Presentation of data**	
	A	Classification, tabulation, diagrammatic & graphical representation of groupeddata.	CO1
	B	Frequency distributions, cumulative frequency distributions	CO1
	C	Histogram, Ogives, frequency polygon, Tree and leaf diagram.	CO1
	Unit 2	**Descriptive statistics**	CO2
	A	Measures of central tendency – arithmetic mean, median, quartiles, mode, harmonicmean, geometric mean.	CO2
	B	Their properties, merits, and demerits	CO2
	C	Measures of dispersion, range, quartile deviation, mean deviation, standard deviation,and coefficient of variation.	
	Unit 3	**Moments**	CO3
	A	Moments, Skewness, Measures of skewness: Karl Pearson's coefficient of skewness.	CO3
	B	Quartile, coefficient of skewness, Measure of skewness based on moments.	CO3

	C	Kurtosis, Measures 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 problems.	CO6
	Mode of examination	Theory	
	Weightage Distribution	CA:25%; ESE:75%	
	Text book/s*	1. Gupta, S.C. and Kapoor, V.K., "Fundamentals of Mathematical Statistics".	
	Other References	1. Grewal, B.S, "Higher Engineering Mathematics". 2. Rohatgi, V.K. "Introduction to Probability".	

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

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

School: SSBSR		**Batch: 2024-28**	
Programme: B.Sc. (Hons.)		**Academic Year: 2024-25**	
Branch: Data Science & Analytics		**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	To understand and demonstrate how to solve logical and scientific problems using programming.	
6	Course Outcomes	CO1: Illustrate and explain the basic computer concepts and programming principles of C language (K2, K3, K4). CO2: Apply and practice the logical ability to solve problems. (K2, K3, K4). CO3: Describe how to generate efficient and schematic solutions to the problems. (K1, K2). CO4: Demonstrate the algorithm, Pseudo-code, and flow chart for the given problem (K2, K3, K4). CO5: Create and implement logic using Operators and control statements. CO6: Develop a better understanding of basic concepts of C programming and Computer Organization.	
7	Course Description	To understand and demonstrate how to solve logical and scientific problems using C programming.	
8			
	Unit 1		
	A	Introduction to Digital Computers, Representation of Algorithm, Flowcharts, Examples. Introduction to Programming: Importance of C, Basic Structure of C Programs, Programming Style, Executing a C Program.	CO1
	B	Constants, Variables, and Data Types: Introduction, Character Set, C Tokens, Keywords, and Identifiers, Constants, Variables,	CO1
	C	Data Types, Declaration of Variables, Assigning Values to Variables, Defining Symbolic Constants. Managing Input and Output Operations: Reading a Character, Writing a Character, Formatted Input, Formatted Output.	CO1
	Unit 2		
	A	Operators and Expressions: Introduction, Arithmetic Operators, Relational Operators, Logical Operators, Assignment Operators, Increment and Decrement Operators, Conditional Operator, Bitwise Operators, Special Operators, Arithmetic Expressions, Evaluation of Expressions, Precedence of Arithmetic Operators, Type Conversions in Expressions, Operator Precedence and Associativity.	CO2
	B	Decision Making and Branching: Introduction, Decision Making with IF Statement, Simple IF Statement, the IF.....ELSE Statement, Nesting of IF....ELSE Statements, The ELSE IF Ladder, The Switch statement	CO2
	C	Decision Making and Looping: The WHILE Statement, The DO Statement, the FOR Statement, Jumps in LOOPS.	CO2
	Unit 3		
	A	Arrays: One-dimensional Arrays, Declaration of One-dimensional Arrays, Initialization of One-dimensional Arrays,	CO3
	B	Two-dimensional Arrays, Declaration of Two-dimensional Arrays, Initialization of Two-dimensional Arrays,	CO3
	C	Example programs – Linear search, Binary search, Bubble sort, and Selection sort. Matrix Multiplication, Transpose of a matrix.	CO3

	Unit 4		
	A	Character Arrays and Strings: Declaring and Initializing String Variables, Reading Strings from the Terminal, Writing Strings to Screen, Arithmetic Operations on Characters,	CO4
	B	String-handling Functions (strlen(), strcpy(), strcmp(), strcat(), strrev()), Example Programs (with and without using built-in string functions), Two-dimensional character arrays.	CO4,CO5
	C	Introduction, Declaring Pointer Variables, Initialization of Pointer variables, accessing a Variable through its Pointer, Pointer Expressions, Pointer Increments and Scale Factor, Pointers and 1-D Arrays.	CO4, CO5
	Unit 5		
	A	Elements of User-defined Functions, Definition of Functions, Return Values and their Types, Function Calls, Function Declaration, Category of Functions	CO5
	B	No Arguments and no Return Values, Arguments but no Return values, Arguments with Return Values, No Arguments but Returns a Value, Passing Arrays to Functions.	CO5, CO6
	C	Recursion - Factorial of an integer, Xn, Finding n th Fibonacci numbers	CO5, CO6
	Mode of examination	Theory	
	Weightage Distribution	CA:25%; ESE:75%	
	Text book/s*	1. E. Balagurusamy, Programming in ANSI C, 5th Edition, Tata McGraw-Hill Publications. 2. P B Kottur, Computer Concepts and C Programming	
	Other References	1. Kerningham Dennis Ritchie, The C programming language (ANSI C version), 2nd Edition, PHI India 2. Jeri R Hanly Elliot B Koffman, Problem-solving and program design in C Person Addison 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
CSE113.1	3	3	2	2		1					1			
CSE113.2	2	3	3	2		1					1			
CSE113.3	2	2	2	3		1					1			
CSE113.4	2	3	2	2		1					1			
CSE113.5	3	3	2	2		1					1			
CSE113.6	3	3	2	3		1					1			
Average	**2.3**	**2.6**	**2.0**	**2.1**		**1.0**					**1.0**			

School: SSBSR		**Batch: 2024-28**	
Programme: B.Sc. (Hons.)		**Academic Year: 2024-25**	
Branch: Data Science & Analytics		**Semester: I**	
1	Course Code	**VOM103**	
2	Course Title	**Essential Excel Skills for Business**	
3	Credits	3	
4	Contact Hours (L-T-P)	0-0-3	
	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 fulfill 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			
	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, Finding and Replacing, Filtering, Sorting, Conditional Formatting.	CO2
	C	Print Preview, Orientation, Margins, 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	
	Weightage Distribution	CA: 25%; CE: 25%; ETE: 50%	
	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	1	
VOM103.2		2	1	2		1		3			1	1	1	
VOM103.3		2	1	2		1		3			1	1	1	
VOM103.4		2	1	2		1		3			1	1	1	
VOM103.5		2	1	2		1		3			1	1	1	
VOM103.6		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: 2024-28**	
Programme: B.Sc. (Hons.)		**Academic Year: 2024-25**	
Branch: Data Science & Analytics		**Semester: I**	
1	Course Code	**ARP101**	
2	Course Title	**Communicative English-1**	
3	Credits	2	
4	Contact Hours (L-T-P)	1-0-2	
	Course Status	AEC	
5	Course Objective	To minimize the linguistic barriers that emerge in varied socio-linguistic environments through the use of English. Help students to understand different accents and standardize their existing English. Guide the students to hone their basic communication skills - listening, speaking, reading, and writing while also uplifting their perception of themselves, giving them self-confidence and building a 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, and 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 potential 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 the varied work 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			
	Unit 1	**Sentence Structure**	**CO Mapping**
	A	Subject Verb Agreement	CO1
	B	Parts of speech	CO1
	C	Writing well-formed sentences	CO1
	Unit 2	**Vocabulary Building & Punctuation**	
	A	Homonyms/ homophones, Synonyms/Antonyms	CO1, CO2
	B	Punctuation/ Spellings (Prefixes-suffixes/Unjumbled Words)	CO1, CO2
	C	Conjunctions/Compound Sentences	CO1, CO2
	Unit 3	**Writing Skills**	
	A	Picture Description – Student Group Activity	CO1
	B	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

	C	Story Completion Exercise –Building positive attitude - The Man from Earth (Watching a Full-length Feature Film)	CO2, CO3
		Digital Literacy | Effective Use of Social Media	CO2, CO3
	Unit 4	**Speaking Skill**	CO3
	A	Self-introduction/Greeting/Meeting people – Self-branding	CO3
	B	Describing people and situations - To Sir with Love (Watching a Full-length Feature Film)	CO4
	C	Dialogues/conversations (Situation based Role Plays)	CO4
	Unit 5	**Professional Skills | Career Skills**	CO4
	A	Exploring Career Opportunities	CO4, CO5
	B	Brainstorming Techniques & Models	CO4, CO5
	C	Social and Cultural Etiquettes	CO4, CO5
	D	Internal Communication	CO4, CO5
	Unit 6	**Leadership and Management Skills**	
	A	Managerial Skills	CO4, CO5
	B	Entrepreneurial Skills	CO4, CO5
	Mode of examination	Class Assignments/Free Speech Exercises / JAM Group Presentations/Problem-Solving Scenarios/GD/Simulations	
	Weightage Distribution	60% CA and 40% ETE	
	Text book/s*	Blum, M. Rosen. How to Build Better Vocabulary. London: Bloomsbury Publication	
	Other References	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	1	2	2	2		1	1	3	1		1			
ARP101.2	1	2	3	2		1	1	3	1		1			
ARP101.3	1	2	2	2		1	1	3	1		1			
ARP101.4	1	2	2	2		1	1	3	1		1			
ARP101.5	1	2	2	2		1	1	3	1		1			
ARP101.6	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**			

School: SSBSR		**Batch: 2024-28**	
Programme: B.Sc. (Hons.)		**Academic Year: 2024-25**	
Branch: Data Science & Analytics		**Semester: I**	
1	Course Code	**VAC103**	
2	Course Title	**Environment 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 science 2.Provide students an insight into 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 with sustainable practices and environmental management	
6	Course Outcomes	CO1.Develop a better understanding of the principles and scope of environmental science 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 various types of natural resources and their conservation CO5. Develop a better understanding of sustainable practices and environmental management CO6. Function effectively an overall understanding of various environmental components, their protection, and management.	
7	Course Description	Environmental Science emphasizes various factors as 1.Importance and scope of environmental science 2.Natural resource conservation 3.Pollution causes, effects, and control methods 4.Sustainable and Environmental environment	
8			
	Unit 1	**Natural resource management**	
	A	Introduction to Natural Resources	CO1/CO6
	B	Management of Land and Forest Resources	CO1/CO6
	C	Water and Energy resource Management	CO1/CO6
	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 the greenhouse effect	CO3/CO6
	B	Ozone layer Depletion and its consequences	CO3/CO6
	C	Climate change, its effect on the 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	CO4/CO6
	B	Environmental Issues and Management in India	CO4/CO6
	C	Environmental Management System (EMS)	CO4/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	2. Environmental Science by G. Tyler Miller, JR. and Scott E. Spoolman; Broks/Cole.	

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
VAC103.1	1	2	2	2		1	1	3	1		2			
VAC103.2	1	2	3	2		1	1	3	1		2			
VAC103.3	1	2	2	2		1	1	3	1		2			
VAC103.4	1	2	2	2		1	1	3	1		2			
VAC103.5	1	2	2	2		1	1	3	1		2			
VAC103.6	1	2	2	2		1	1	3	1		2			
Average	**1.0**	**2.0**	**2.0**	**2.0**		**1.0**	**1.0**	**3.0**	**1.0**		**2.0**			

School: SSBSR		**Batch: 2024-28**	
Programme: B.Sc. (Hons.)		**Academic Year: 2024-25**	
Branch: Data Science & Analytics		**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	To familiarise the students with basic concepts of matrices, determinants, and solving the system of linear equations. To understand the basic concept of sets theory, coordinate geometry, complex number, and vector algebra.	
6	Course Outcomes	**CO1:** The main objective of the course is to equip the student to plot the different graphs 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, students would be able to know the convergence of sequences through plotting, verify the 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.** Students would be able to plot Complex numbers and their representations, Operations like addition, subtraction, Multiplication, Division, Modulus and Graphical representation of polar form. (K2,K3,K4) **CO4**: Student would be able to perform the following task of the 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 evaluating linear system of equations, ordinary differential equations in Mathematica /MATLAB /Maple /Scilab/Maxima. (K4,K5,K6).	
7	Course Description	To familiarise the students with basic concepts of matrices, determinants, and solving the system of linear equations. To understand the basic concept of sets theory, coordinate geometry, complex number, and vector algebra.	
8	**Outline syllabus**		**CO Mapping**
	Unit 1	**List of the practicals to be done using Mathematica /MATLAB /Maple /Scilab/Maxima etc.**	
	A, B, C	Plotting the graphs of the following functions: (i) ax (ii) [x] (greatest integer function) (iii) x 2n ; n ∈ N (iv) x 2n−1 ; n ∈ N (v) 1 ;n ∈ N X 2n−1 (vi) 1 ;n ∈ N X 2n	CO1, CO6
	Unit 2	**List of the practicals to be done using Mathematica /MATLAB /Maple /Scilab/Maxima etc.**	
	A, B, C	(vii) √ax + b, |ax + b|, c ± |ax + b|	CO1, CO2

		(viii) |X|, sin (1 , x sin 1 , eX, e−X for x ≠ 0.) ( ) X X X (ix) e ax+b, log(ax + b) , 1 , sin(ax + b), cos(ax + b) , |sin(ax+b)|,|cos(ax + b)|. ax+b Observe and discuss the effect of changes in the real constants a and b on the graphs.	
	Unit 3	**List of the practicals to be done using Mathematica /MATLAB /Maple /Scilab/Maxima etc.**	
	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, CO6
	Unit 4	**List of the practicals to be done using Mathematica /MATLAB /Maple /Scilab/Maxima etc.**	
	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	**List of the practicals to be done using Mathematica /MATLAB /Maple /Scilab/Maxima etc.**	
	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		
CMS151.2	1	2	3	2		1	1	3	1		1	1		
CMS151.3	1	2	2	2		1	1	3	1		1	1		
CMS151.4	1	2	2	2		1	1	3	1		1	1		
CMS151.5	1	2	2	2		1	1	3	1		1	1		
CMS151.6	1	2	2	2		1	1	3	1		1	1		
Average	**1.0**	**2.0**	**2.0**	**2.0**		**1.0**	**1.0**	**3.0**	**1.0**		**1.0**	**1.0**		

School: SSBSR		Batch: 2024-28	
Programme: B.Sc. (Hons.)		Academic Year: 2024-25	
Branch: Data Science & Analytics		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	To understand and demonstrate how to solve logical and scientific problems using programming C.	
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 CO5: Develop the uses of computers in the engineering industry. (K4, K5, K6) CO6: Discuss the more advanced features of the C language (K3, K4, K6).	
7	Course Description	To understand and demonstrate how to solve logical and scientific problems using programming C.	
8	**Outline syllabus**		**CO Mapping**
	Unit 1	**Lab. Experiment 1:**	
	A, B, C	Write a c program to swap two numbers with a temporary variable. Write a c program to swap two numbers without a temporary variable.	CO1, CO2
	Unit 2	**Lab. Experiment 2:**	
	A, B, C	Write a c Program to Add Two Integers. Write a program to check given year is leap year.	CO2, CO3
	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 students 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. 2. R. G. Dromey, “How to Solve It by Computer”, 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
CSP113.1	1	2	2	2		1	1	3	1		2	1		
CSP113.2	1	2	3	2		1	1	3	1		2	1		
CSP113.3	1	2	2	2		1	1	3	1		2	1		
CSP113.4	1	2	2	2		1	1	3	1		2	1		
CSP113.5	1	2	2	2		1	1	3	1		2	1		
CSP113.6	1	2	2	2		1	1	3	1		2	1		
Average	**1.0**	**2.0**	**2.0**	**2.0**		**1.0**	**1.0**	**3.0**	**1.0**		**2.0**	**1.0**		

School: SSBSR		**Batch: 2024-28**	
Programme: B.Sc. (Hons.)		**Academic Year: 2024-25**	
Branch: Data Science & Analytics		**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 their 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 the algebra of matrices and elementary row operations and calculate the rank of the matrix and analyze the consistency of a linear system. (K1, K2, K3) CO2: Explain the concept of Eigenvalues and Eigenvectors; evaluate the diagonalization of matrices and quadratic & bilinear forms. (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 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, and Gram-Schmidt orthogonalization. (K4, K5, K6)	
7	Course Description	This course introduces the basic algebra of matrices, and their applications, vector space, Linear transformation and its properties, and 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, and 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 the consistency of a system of linear equations.	CO 1, CO 6
	Unit 2	**Matrix Analysis -II**	
	A	Eigenvalues, Eigenvectors, and characteristic equations of a matrix.	CO 2, CO 6
	B	Cayley Hamilton theorem and its application, Diagonalization.	CO 2, CO 5
	C	Quadratic forms, Matrix of quadratic forms, Bilinear forms, Matrix of 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
	B	Basis of a Finite Dimensional Vector Space, Linear Transformations, Results on Linear Transformation.	CO 3
	C	Range and Kernel of a Linear Transformation, Rank and Nullity, Rank-Nullity Theorem.	CO 3, CO 5

	Unit 4	**Linear Transformations-II**	
	A	Linear operators, Invertible Linear Transformations.	CO 4
	B	Matrix of a Linear Transformation, Matrix of the sum and product of linear transformations.	CO 4
	C	Linear transformation of a Quadratic Form and its theorems.	CO 4
	Unit 5	**Orthogonality**	
	A	Inner Product Space (definition and examples), Cauchy- Schwartz inequality.	CO 5
	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. Strang G, Linear Algebra and its applications, 3rd edition, Thomson. 2. Krishnamurthy V, Mainra V P, Arora J L, An introduction to Linear Algebra.	
	Other References	1. Lipshutz S, Lipson M, Linear Algebra, 3rd edition, Schaum's Outline series. 2. Kreyszig E, Advanced Engineering Mathematics, John Wiley & 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
CMS131.1	3	3	2	2		1					1		1	
CMS131.2	2	2	2	2		1					1		1	
CMS131.3	3	3	3	3		1					1		1	
CMS131.4	2	2	2	3		1					1		1	
CMS131.5	2	3	3	3		1					1		1	
CMS131.6	3	2	3	3		1					1		1	
Average	**2.5**	**2.5**	**2.5**	**2.6**		**1.0**					**1.0**		**1.0**	

School: SSBSR		**Batch: 2024-28**	
Programme: B.Sc. (Hons.)		**Academic Year: 2024-25**	
Branch: Data Science & Analytics		**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 the modeling 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 modeling. 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 p robability distributions and their applications in real life; and limit theorems. (K2,K3). CO5: Monte Carlo simulation of simple probability models, entropy, and mutual information. (K2, K5) CO6: Develop the skills to interpret the results of statistical analysis. (K2, K5).	
7	Course Description	This is an introductory course in probability. Axioms of probability, conditional probability and independence, Bayes theorem, and probability distributions.	
8	**Outline syllabus**		**CO Mapping**
	Unit 1	**Mathematical Expectation**	
	A	Axioms of probability, conditional probability and independence, Bayes theorem,	CO1
	B	Random variables: discrete and continuous random variables, probability mass function (p.m.f), probability density function (p.d.f) and cumulative distribution function (c.d.f), Illustrations and properties of random variables.	CO1
	C	Mathematical Expectation: Expectation of single and bivariate random variables, properties of expectation, conditional expectation, and its properties. Moments and cumulants. Moment generating function, probability generating function.	CO1
	Unit 2	**Discrete Random Variable**	
	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	CO2
	Unit 3	**Continuous Random Variable**	
	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	CO3

		demerits.	
	C	Markov inequality and Chebyshev's inequality.	CO3
	Unit 4	**Jointly Distributed Random Variables**	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	**Generation of Random Numbers**	
	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. Gupta, S.C. and Kapoor, V.K., "Fundamentals of Mathematical Statistics".	
	Other References	1. Grewal, B.S, "Higher Engineering Mathematics". 2. 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	3	3	2	2		1					1	1	1	
CMS132.2	2	3	3	2		1					1	1	1	
CMS132.3	2	2	2	3		1					1	1	1	
CMS132.4	2	3	2	2		1					1	1	1	
CMS132.5	3	3	2	2		1					1	1	1	
CMS132.6	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: 2024-28**	
Programme: B.Sc. (Hons.)		**Academic Year: 2024-25**	
Branch: Data Science & Analytics		**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	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, a 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			
	Unit 1		
	A	Basic Terminologies: Elementary Data Organizations,	CO1
	B	Data Structure Operations: insertion	CO1
	C	deletion, traversal, etc.	CO1
	Unit 2		
	A	Analysis of an Algorithm, Asymptotic;	CO2
	B	Notations, Time-Space trade-off. Searching: Linear Search	CO2
	C	Binary Search Techniques and their complexity analysis.	CO2
	Unit 3		
	A	Stacks and Queues: ADT Stack and its operations: Algorithms and their complexity analysis,	CO3
	B	Applications of Stacks: Expression Conversion and evaluation – corresponding algorithms and complexity analysis.	CO3
	C	ADT queue, Types of Queue: Simple Queue, Circular Queue, Priority Queue; Operations on each type of Queues: Algorithms and their analysis.	CO3
	Unit 4		
	A	Linked Lists: Singly linked lists: Representation in memory, Algorithms of several operations: Traversing, Searching, Insertion into, Deletion from the linked list;	CO4
	B	Linked representation of Stack and Queue, Header nodes,	CO4

		Doubly linked list: operations on it and algorithmic analysis; Circular Linked Lists: all operations their algorithms and the complexity analysis.	
	C	Trees: Basic Tree Terminologies, Different types of Trees: Binary Tree, Threaded Binary Tree, Binary Search Tree, AVL Tree; Tree operations on each of the trees and their algorithms with complexity analysis. Applications of Binary Trees. B Tree, B+ Tree: definitions, algorithms, and analysis.	CO5
	Unit 5	Sorting and Hashing: Objective and properties of different sorting algorithms: Selection Sort, Bubble Sort, Insertion Sort, Quick Sort, Merge Sort, Heap Sort;	CO5
	A	Performance and Comparison among all the methods, Hashing.	CO5
	B	Graph: Basic Terminologies and Representations, Graph search and traversal algorithms, and complexity analysis.	CO6
	C	Basic Terminologies: Elementary Data Organizations.	CO6
	Mode of examination	Theory	
	Weightage Distribution	CA:25%; ESE:75%	
	Text book/s*	1. Fundamentals of Data Structures", Illustrated Edition by Ellis Horowitz, Sartaj Sahni, Computer Science Press.	
	Other References	1. Algorithms, Data Structures, and Problem-Solving with C++", Illustrated Edition by Mark Allen Weiss, Addison-Wesley Publishing Company. 2. How to Solve it by Computer", 2nd Impression by R. G. Dromey, Pearson Education.	

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	3	3	2	2		1					1			
CSE242.2	2	3	3	2		1					1			
CSE242.3	2	2	2	3		1					1			
CSE242.4	2	3	2	2		1					1			
CSE242.5	3	3	2	2		1					1			
CSE242.6	3	3	2	3		1					1			
Average	**2.3**	**2.6**	**2.0**	**2.1**		**1.0**					**1.0**			

School: SSBSR		**Batch: 2024-28**	
Programme: B.Sc. (Hons.)		**Academic Year: 2024-25**	
Branch: Data Science & Analytics		**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 that are all too common that we encounter every day. 2. To learn to confidently operate this Excel means adding a highly valuable asset to the 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, and resolve circular references. CO6: Create protected worksheets and workbooks.	
7	Course Description	In offices 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			
	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%; ETE: 50%	
	Text book/s*	1.Michael Alexander, Excel® Dashboards & Reports for Dummies, John Wiley & Sons, Inc, ISBN: 978-1-119-07676-6, 2016.	
	Other References	1. Michael Alexander and Dick Kusleika, Excel 2016 Formulas, John Wiley & Sons, Inc, ISBN: 978-1-119-06786-3, 2016.	

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PSO 1**	**PSO 2**	**PSO 3**
VOM104.1		2	1	2		1		3					1	1
VOM104.2		2	1	2		1		3					1	1
VOM104.3		2	1	2		1		3					1	1
VOM104.4		2	1	2		1		3					1	1
VOM104.5		2	1	2		1		3					1	1
VOM104.6		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: 2024-28**	
Programme: B.Sc. (Hons.)		**Academic Year: 2024-25**	
Branch: Data Science & Analytics		**Semester: II**	
1	Course Code	**ARP102**	
2	Course Title	**Communicative English -2**	
3	Credits	2	
4	Contact Hours (L-T-P)	1-0-2	
	Course Status	AEC	
5	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, and long and short essays.	
6	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 by defining strategies for effective communication with different people CO5: Realize their potential as human beings and conduct themselves properly in the ways of the world. CO6 Acquire satisfactory competency in the use of Quantitative aptitude and Logical Reasoning	
7	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 a minimum to increase employability chances.	
8			
	Unit 1	**Acquiring Vision, Goals, and Strategies through Audio-visual Language Texts**	
	A	Pursuit of Happiness / Goal Setting & Value Proposition in life	CO1
	B	12 Angry Men / Ethics & Principles	CO1
	C	The King's Speech / Mission statement in life | strategies & Action Plans in Life	CO1
	Unit 2	**Creative Writing**	CO2
	A	Story Reconstruction - Positive Thinking	CO2
	B	Theme-based Story Writing - Positive attitude	CO2
	C	Learning Diary Learning Log – Self-introspection	
	Unit 3	**Writing Skills 1**	CO3
	A	Precis	CO3
	B	Paraphrasing	CO3
	C	Essays (Simple essays)	
	Unit 4	**MTI Reduction/Neutral Accent through Classroom Sessions & Practice**	CO4
	A	Vowel, Consonant, sound correction, speech sounds, Monothongs, Diphthongs and Tripthongs	CO4
	B	Vowel Sound drills, Consonant Sound drills, Affricates and Fricative Sounds	CO4
	C	Speech Sounds | Speech Music| Tone | Volume| Diction |Syntax |Intonation | Syllable Stress |	CO4

	Unit 5	**Gauging MTI Reduction Effectiveness through Free Speech**	
	A	Jam sessions	CO4
	B	Extempore	
	C	Situation-based Role Play	CO5
	Unit 6	**Leadership and Management Skills**	
	A	Innovative Leadership and Design Thinking	CO5
	B	Ethics and Integrity	CO5
	Unit 7	**Universal Human Values**	
	A	Love & Compassion, Non-Violence & Truth	CO5
	B	Righteousness, Peace	CO6
	C	Service, Renunciation (Sacrifice)	CO6
	Unit 8	**Introduction to Quantitative aptitude & Logical Reasoning**	
	A	Analytical Reasoning & Puzzle Solving	CO6
	B	Number Systems and its Application in Solving Problems	CO6
	Mode of examination	Class Assignments/Free Speech Exercises / JAM Group Presentations/Problem-Solving Scenarios/GD/Simulations	
	Weightage Distribution	60% CA and 40% ETE	
	Text book/s*	Wren, P.C.&Martin H. High English Grammar and Composition, S.Chand& Company Ltd, New Delhi.	
	Other References	Blum, M. Rosen. How to Build Better Vocabulary. London: Bloomsbury Publication 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	1	2	2	2		1	1	3	1					
ARP102.2	1	2	3	2		1	1	3	1					
ARP102.3	1	2	2	2		1	1	3	1					
ARP102.4	1	2	2	2		1	1	3	1					
ARP102.5	1	2	2	2		1	1	3	1					
ARP102.6	1	2	2	2		1	1	3	1					
Average	**1.0**	**2.0**	**2.0**	**2.0**		**1.0**	**1.0**	**3.0**	**1.0**					

School: SSBSR		**Batch: 2024-28**	
Programme: B.Sc. (Hons.)		**Academic Year: 2024-25**	
Branch: Computational Mathematics & Statistics		**Semester: II**	
1	Course Code	**VAC110**	
2	Course Title	**Yoga for Holistic Health**	
3	Credits	3	
4	Contact Hours (L-T-P)	0-1-4	
	Course Status	VAC	
5	Course Objective	To make the students familiar with the different practices of yoga, chanting and meditation 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			
	Unit 1	**Importance of Health, Wellness through Yoga**	
	A	Meaning, Definition, Aim of Yoga; Concept of health according to WHO and Ayurveda	CO1, CO2, CO4, CO5, CO6
	B	Misconception about Yoga, Difference between asana and physical exercise	CO1, CO2, CO4, CO5, CO6
	C	Need, Importance of Yoga in health and wellness	CO1, CO2, CO4, CO5, CO6
	Unit 2	**Schools of Yoga, Modern and Ancient schools of Yoga existing in India, Yogic diet, Yogic attitudes, Sadhak tatva & Badhak tatva**	
	A	Schools/ Streams of Yoga – Ashtanga Yoga, Bhakti Yoga, Karma Yoga, Jnana Yoga	CO3, CO4, CO5, CO6
	B	Modern and ancient schools of Yoga existing in India – Natha Sampradaya, Kaivalyadhama, Bihar School of Yoga, Munger, Pragya Yoga (Shantikunj), Iyengar Yoga, Patanjali Yoga Peeth, Ashtanga Vinyasa Yoga	CO3, CO4, CO5, CO6
	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	CO4, CO5, CO6

		School of Yoga) Part-1	
	B	Sukshma Vyayama & their benefits for health (Swami Dhirendra Brahmachari) Part-1	CO4, CO5, CO6
	C	Surya Namaskara (Sun Salutation) with mantra chanting (12 steps) & their benefits for health	CO4, CO5, CO6
	Unit 4	**Asana - all categories**	
	A	Standing & Sitting - Tadasana, Vrikshasana, Katichakrasana, Padmasana, Vajrasana, Ushtrasana, Paschimottanasana, Vakrasana	CO4, CO5, CO6
	B	Supine and Prone: Uttanapadasana, Pawanamuktasana, Shalabhasana, Bhujangasana	CO4, CO5, CO6
	C	Balancing and Inverted: Trivikramasana, Sarvangasana, Viparitakarani mudra	CO4, CO5, CO6
	Unit 5	**Pre-practices of Pranayama, Pranayama and Dhyana**	
	A	Kapalabhati, Mukha dhauti, Vibhagiya pranayama (Sectional breathing)	CO1, CO4, CO5, CO6
	B	Anuloma – Viloma, Bhastrika, Shitali	CO1, CO4, CO5, CO6
	C	Om Dhyana, Aanapaanasati Dhyana (breath meditation)	CO1, CO4, CO5, CO6
	Mode of examination	Theory and Practical	
	Weightage Distribution	CA:60%; ESE:40%	
	Text book/s*	Sri Ananda: The Complete book of Yoga, Orient Course Backs, Delhi,2003.	
	Other References	1. Sri Ananda: The Complete book of Yoga, Orient Course Backs, Delhi,2003. 2. Basavaraddi, I.V. & other: SHATKARMA: A Comprehensive description about Cleansing Process, MDNIY New Delhi, 2009 3. Joshi, K.S.: Yogic Pranayama, Oriental Paperback, New Delhi, 2009 4. Dr. Nagendra H R: Pranayama, The Art & Science, Swami VivekanandaYoga Prakashan, Bangalore, 2005. 5. Swami Niranjanananda Saraswati: Asana Pranayama Mudra Bandha, Yoga Publication Trust, Munger Bihar. 6. Joshi, K.S.: Yogic Pranayama, Oriental Paperback, New Delhi, 2009 7. Swami Kuvalyananda: Pranayama, Kaivalyadhama, Lonavla, 2010	

		8. Swami Rama: Science of Breath, A Practical Guide, The Himalayan International Institute, Pennselvenia, 1998. 9. Swami Niranjanananda Saraswati: Prana, Pranayama & Pranavidya, Yoga Publications Trust, Munger, Bihar, 2005	

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

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

School: SSBSR		**Batch: 2024-28**	
Programme: B.Sc. (Hons.)		**Academic Year: 2024-25**	
Branch: Data Science & Analytics		**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 the 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 the 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 MATLAB in Matrix analysis and Linear algebra. The primary objective of the course is to develop basic mathematical modeling and 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 form, Matrix of a Bilinear form, 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	
	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. 2. D.R. Hill and D.E. Zitarelli, Linear Algebra Labs with MATLAB, Second edition, Prentice Hall, Upper Saddle River.	
	Other References	1. R.E. Larson and B.H. Edwards, Elementary Linear Algebra, Third edition, D.C. Heath and Company, Lexington, MA. 2. S.J. Leon, Linear Algebra with Applications, Fifth edition, Prentice Hall, Upper Saddle River.	

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		3	2	3	2	3	2	3	2	2	1	1	2	1
CMS171.2		3	3	3	3	2	3	3	2	2	1	1	2	1
CMS171.3		3	2	2	2	2	3	3	2	2	1	1	2	1
CMS171.4		3	2	3	2	3	2	3	3	2	1	1	2	1
CMS171.5		3	2	2	2	2	3	3	2	2	1	1	2	1
CMS171.6		3	2	3	2	3	2	3	3	2	1	1	2	1
Average		**3.0**	**2.2**	**2.7**	**2.7**	**2.5**	**2.5**	**3.0**	**2.3**	**2.0**	**1.0**	**1.0**	**2.0**	**1.0**

School: SSBSR		**Batch: 2024-28**	
Programme: B.Sc. (Hons.)		**Academic Year: 2024-25**	
Branch: Data Science & Analytics		**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	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, a 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	**Lab. Experiment 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	**Lab. Experiment 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).	CO2, CO3
	Unit 3	**Lab. Experiment 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.	CO3, CO4
	Unit 4	**Lab. Experiment 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.	CO4, CO5, CO6
	Unit 5	**Lab. Experiment 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. 2. How to Solve it by Computer", 2nd Impression by R. G. Dromey, Pearson Education.	

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

DATA SCIENCE & ANALYTICS

School: SSBSR		**Batch: 2024-28**	
Programme: B.Sc. (Hons.)		**Academic Year: 2025-26**	
Branch: Data Science & Analytics		**Semester: III**	
1	Course Code	**MSM312**	
2	Course Title	**Discrete Mathematics**	
3	Credits	4	
4	Contact Hours (L-T-P)	3-1-0	
	Course Status	DSE	
5	Course Objective	This course is aimed to provide an advanced understanding of 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, the principle of inclusion and exclusion, multisets, propositions, and conditional propositions, and evaluate normal forms, Mathematical induction. (K2, K3, K4, K5) CO2: Describe the concept functions, the composition of functions, invertible functions, and discrete properties of binary relations and check the closure of relations. (K3, K6) CO3: 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 discussing linear recurrence relations with constant coefficient, homogeneous solution, total solutions, and solutions by method of Generating function. (K2, K4, K5) CO4: Illustrate the concept permutations and combinations: rule of sum and product, write the algorithms for the generation of permutations and combination. (K3, K5, K6) CO5: Discuss the concept graph, sub-graph, Walks, Path and circuits, connected graphs, disconnected graphs, and components, and evaluate the fundamental circuits, distance, diameters, radius, and pendant vertices, rooted and binary trees (K1, K2, K5, K6) CO6: Demonstrate an understanding of Algebraic systems, Group and evaluate Semi-groups, Monoid, Subgroups, Isomorphism, and Automorphism. (K2, K5)	
7	Course Description	This course is given a deep knowledge of sets and propositions, relations and functions, permutation and combination, graphs, groups, and rings.	
8	**Outline syllabus**		**CO Mapping**
	Unit 1	**Sets and Propositions**	
	A	Sets, Un-countably infinite sets, Principle of inclusion and exclusion, multisets, propositions,	CO1
	B	Conditional propositions. Logical connectivity, Propositional, calculus,	CO1, CO2
	C	Universal and existential quantifiers, Normal forms, methods of proofs, Mathematical induction.	CO2
	Unit 2	**Relations and Functions**	CO3
	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.	
	Unit 3	**Number Theory**	CO4
	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.	
	Unit 4	**Recurrence Relations and Algebraic Structures**	CO5
	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.	
	Unit 5	**Algebraic Structures**	CO6
	A	Algebraic systems, Group, Semi-groups, Monoid, Subgroups.	CO6
	B	Cyclic group, Permutation groups, Homomorphism,	CO6
	C	Isomorphism and Automorphism of groups.	
	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. 2. Biggs N., "Discrete Mathematics", 3rd edition, Oxford University	

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
MSM312.1		3	2	2		1					1			
MSM312.2		3	3	2		1					1			
MSM312.3		2	2	3		1					1			
MSM312.4		3	2	2		1					1			
MSM312.5		3	2	2		1					1			
MSM312.6		3	2	3		1					1			
Average		**2.6**	**2.0**	**2.1**		**1.0**					**1.0**			

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

	A	Introduction to transportation problem-I, Transportation problem-II, Vogel Approximation method, optimal solution Generation for Transportation problem and Degeneracy in TP and problems.	CO3
	B	Introduction to Nonlinear Programming, Graphical Solution of NLP, and Types of NLP.	CO3
	C	One-dimensional unconstrained optimization, Region Elimination Technique-1, Region Elimination Technique-2, and Region Elimination Technique-3.	CO3
	Unit 4	**NLP and Unconstrained optimization**	
	A	Multivariate Unconstrained Optimization-1, Multivariate Unconstrained Optimization-2.	CO4
	B	NLP with Equality Constrained-1, NLP with Equality Constrained-2, Constrained NLP-1, and Constrained NLP 2.	CO4
	C	Constrained Optimization, Constrained Optimization, and KKT (Karush-Kuhn-Tucker conditions)	CO4
	Unit 5	**Constrained optimization and Dynamic programming of LPP**	
	A	Constrained Optimization, Constrained Optimization, and Feasible Direction.	CO5
	B	Penalty and barrier method, Penalty method, and Penalty and barrier method.	CO5
	C	Dynamic programming, Multi-Objective decision-making, and Multi-Attribute decision-making.	CO6
	Mode of examination	Theory	
	Weightage Distribution	CA:25%; ESE:75%	
	Text book/s*	1. Kanti Swarup, P.K. Gupta, Man Mohan, Operations Research, Sultan Chand & Sons. 2. S. Chandra, Jayadeva, Aparna Mehra, Numerical Optimization with Applications, Narosa.	
	Other References	1 Hamdy A. Taha, Operations Research, An Introduction, 9th Edition, Pearson. 2. M.S. Bazarra, H.D. Sheral, and C.M. Shetty, Nonlinear Programming Theory and Algorithms.	

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

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
BDA215.1	1	2	2	2	1	1	1	2	3		1			1
BDA215.2	1	2	3	2	1	1	1	2	3		1			1
BDA215.3	1	2	2	2	1	1	1	2	3		1			1
BDA215.4	1	2	3	3	1	1	1	2	3		1			1
BDA215.5	1	2	2	2	1	1	1	2	3		1			1
BDA215.6	1	2	2	2	1	1	1	2	3		1			1
Average	**1.0**	**2.0**	**2.3**	**2.1**	**1.0**	**1.0**	**1.0**	**2.0**	**3.0**		**1.0**			**1.0**

School: SSBSR		**Batch: 2024-28**	
Programme: B.Sc. (Hons.)		**Academic Year: 2025-26**	
Branch: Data Science & Analytics		**Semester: III**	
1	Course Code	**BDA216**	
2	Course Title	**Statistical Inference**	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
	Course Status	CC	
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		CO1
	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.	
	Unit 2		CO3
	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.	
	Unit 3		CO4
	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	
	Unit 4		CO5
	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	
	Unit 5		CO6
	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	CO1
	Mode of examination	Theory	
	Weightage Distribution	CA:25%; ESE:75%	
	Text book/s*	1. Gupta, S.C. and Kapoor, V.K., "Fundamental of Mathematical Statistics".	
	Other References	1. Grewal, B.S, "Higher Engineering Mathematics". 2. 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					1	1	1	1
BDA216.2	2	3	3	2		1					1	1	1	1
BDA216.3	2	2	2	3		1					1	1	1	1
BDA216.4	2	3	2	2		1					1	1	1	1
BDA216.5	3	3	2	2		1					1	1	1	1
BDA216.6	3	3	2	3		1					1	1	1	1
Average	**2.3**	**2.6**	**2.0**	**2.1**		**1.0**					**1.0**	**1.0**	**1.0**	**1.0**

School: SSBSR		**Batch: 2024-28**	
Programme: B.Sc. (Hons.)		**Academic Year: 2025-26**	
Branch: Data Science & Analytics		**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	Compulsory	
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
RBL001.1	3	3	2	2	1	1					2	1		
RBL001.2	2	3	2	2	1	1					2	1		
RBL001.3	2	2	2	3	1	1					2	1		
RBL001.4	2	3	2	2	1	1					2	1		
RBL001.5	3	3	2	2	1	1					2	1		
RBL001.6	3	3	2	3	1	1					2	1		
Average	**2.3**	**2.6**	**2.0**	**2.1**	**1.0**	**1.0**					**2.0**	**1.0**		

School: SSBSR		**Batch: 2024-28**	
Programme: B.Sc. (Hons.)		**Academic Year: 2025-26**	
Branch: Data Science & Analytics		**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	CC	
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		
	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-	CO3C

		Saving Times.	
	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	Theory	
	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 2. Best Practices in Data Cleaning: A Complete Guide to Everything You Need to Do Before and After Collecting Your Data by Jason W Osborne	
	Other References	1. Data Wrangling with Python by Jacqueline Kazil 2. Principles of Data Wrangling: Practical Techniques for Data Preparation by Tye Rattenbury	

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			2		1	1
BDA217.2		2	1	2		1		3			2		1	1
BDA217.3		2	1	2		1		3			2		1	1
BDA217.4		2	1	2		1		3			2		1	1
BDA217.5		2	1	2		1		3			2		1	1
BDA217.6		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: 2024-28**	
Programme: B.Sc. (Hons.)		**Academic Year: 2025-26**	
Branch: Data Science & Analytics		**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. 3. 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%; CE: 25%; ETE: 50%	
	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	2	3	2		2			1
VOM203.2		2	1	2		1	2	3	2		2			1
VOM203.3		2	1	2		1	2	3	2		2			1
VOM203.4		2	1	2		1	2	3	2		2			1
VOM203.5		2	1	2		1	2	3	2		2			1
VOM203.6		2	1	2		1	2	3	2		2			1
Average		**2.0**	**1.0**	**2.0**		**1.0**	**2.0**	**3.0**	**2.0**		**2.0**			**1.0**

School: SSBSR		Batch: 2024-28	
Programme: B.Sc. (Hons.)		Academic Year: 2025-26	
Branch: Data Science & Analytics		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			
	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
	B	Techniques of Self-Awareness | Self-Esteem & Effectiveness| 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			2	2	1	3	1	3	1					
ARP207.2			3	2	1	3	1	3	1					
ARP207.3			2	2	1	3	1	3	1					
ARP207.4			2	2	1	3	1	3	1					
ARP207.5			2	2	1	3	1	3	1					
ARP207.6			2	2	1	3	1	3	1					
Average			**2.0**	**2.0**	**1.0**	**3.0**	**1.0**	**3.0**	**1.0**					

School: SSBSR		Batch: 2024-28	
Programme: B.Sc. (Hons.)		Academic Year: 2025-26	
Branch: Data Science & Analytics		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	CC	
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. Grewal, B.S, "Higher Engineering Mathematics".	

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		1	1	2	
BDA261.2	1	2	3	2		1	1	3	1		1	1	2	
BDA261.3	1	2	2	2		1	1	3	1		1	1	2	
BDA261.4	1	2	2	2		1	1	3	1		1	1	2	
BDA261.5	1	2	2	2		1	1	3	1		1	1	2	
BDA261.6	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: 2024-28**	
Programme: B.Sc. (Hons.)		**Academic Year: 2025-26**	
Branch: Data Science & Analytics		**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	CC	
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 2. Best Practices in Data Cleaning: A Complete Guide to Everything You Need to Do Before and After Collecting Your Data by Jason W Osborne	

	Other References	1. Data Wrangling with Python by Jacqueline Kazil 2. Principles of Data Wrangling: Practical Techniques for Data Preparation by Tye Rattenbury	

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

School: SSBSR		**Batch: 2024-28**	
Programme: B.Sc. (Hons.)		**Academic Year: 2025-26**	
Branch: Data Science & Analytics		**Semester: IV**	
1	Course Code	**BDA218**	
2	Course Title	**Data Ware Housing & Data Mining**	
3	Credits	3	
4	Contact Hours (L-T-P)	3-0-0	
	Course Status		
5	Course Objective	Familiarise students with basic concepts of data warehousing, business analysis, data mining, association rule mining and classification, clustering, and trends in data mining.	
6	Course Outcomes	CO1: Discuss the Data warehousing Components, Cleanup, and transformation Tools - Metadata. (K3, K5) CO2: Explain methods of business analysis, reporting, and query tools and applications. (K2, K3, K4) CO3: Describe the OLAP guideline multidimensional versus multi relational OLAP, categories of tools, OLAP tools, and the internet. (K2, K4) CO4: Explain and illustrate data mining functionalities, the interestingness of patterns, integration of a data mining system with data warehouse issues, and data preprocessing. (K2, K3) CO5: Explain the basic concepts of decision tree induction, bayesian classification, rule-based classification, classification by backpropagation and apply support vector machines, associative classification, lazy learners, other classification methods, and prediction. (K2, K3, K4) CO6: Explain and evaluate clustering and trends in data mining. (K2, K4, K6)	
7	Course Description	This course introduces the basic concepts of data warehousing, business analysis, data mining, association rule mining and classification, clustering, and trends in data mining.	
8	**Outline syllabus**		**CO Mapping**
	Unit 1	**Data Warehousing**	
	A	Data warehousing Components –Building a Data warehouse.	CO1
	B	Mapping the Data Warehouse to a Multiprocessor Architecture – DBMS Schemas for Decision Support	CO1
	C	Data Extraction, Cleanup, and Transformation Tools - Metadata.	CO1
	Unit 2	**Business Analysis**	CO2, CO3
	A	Reporting and Query tools and Applications, Cognos Impromptu, Online Analytical Processing (OLAP).	CO3
	B	Multidimensional Data Model, OLAP Guideline Multidimensional versus Multirotational OLAP,	CO3
	C	Categories of Tools, OLAP Tools, and the Internet.	
	Unit 3	**Data Mining**	CO4
	A	Introduction, Data, Types of Data, Data Mining Functionalities,	CO4
	B	Interestingness of Patterns, Classification of Data Mining Systems, Data Mining Task Primitives,	CO4
	C	Integration of a Data Mining System with Data Warehouse Issues, Data Preprocessing	
	Unit 4	**Association Rule Mining and Classification**	CO5
	A	Mining Frequent Patterns, Associations and Correlations, Mining	CO5

		Methods, Mining various Kinds of Association Rules, Correlation Analysis,	
	B	Constraint-Based Association Mining Classification and Prediction, Basic Concepts, Decision Tree Induction, Bayesian Classification, Rule Based Classification, Classification by Backpropagation,	CO5
	C	Support Vector Machines, Associative Classification, Lazy Learners, Other Classification Methods, and Prediction.	
	Unit 5	**Clustering and Trends in Data Mining**	CO6
	A	Cluster Analysis, Types of Data, Categorization of Major Clustering Methods, K-means, Partitioning Methods, Hierarchical Methods,	CO6
	B	Density-Based Methods, Grid-Based Methods, Model-Based Clustering Methods, Clustering High Dimensional Data, Constraint, Based Cluster Analysis, and Outlier Analysis.	CO6
	C	Data Mining Applications. Apply data mining techniques and methods to large data sets, use data mining tools, and Compare and contrast the various classifiers.	
	Mode of examination	Theory	
	Weightage Distribution	CA:25%; ESE:75%	
	Text book/s*	1. Alex Berson and Stephen J. Smith, "Data Warehousing, Data Mining and OLAP", Tata McGraw Hill 2. Jiawei Han and Micheline Kamber, "Data Mining Concepts and Techniques", Third Edition, Elsevier.	
	Other References	1. Pang-Ning Tan, Michael Steinbach, and Vipin Kumar, "Introduction to Data Mining", Person Education. 2. K.P. Soman, Shyam Diwakar and V. Aja, "Insight into Data Mining Theory and Practice", Eastern Economy Edition, Prentice Hall.	

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
BDA218.1	3	3	2	2		1					1	1		
BDA218.2	2	3	3	2		1					1	1		
BDA218.3	2	2	2	3		1					1	1		
BDA218.4	2	3	2	2		1					1	1		
BDA218.5	3	3	2	2		1					1	1		
BDA218.6	3	3	2	3		1					1	1		
Average	**2.3**	**2.6**	**2.0**	**2.1**		**1.0**					**1.0**	**1.0**		

School: SSBSR		**Batch: 2024-28**	
Programme: B.Sc. (Hons.)		**Academic Year: 2025-26**	
Branch: Data Science & Analytics		**Semester: IV**	
1	Course Code	**BDA202**	
2	Course Title	**Database Management Systems**	
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 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, nested subqueries, Joined relations. Triggers.	CO4
	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. 2 "Fundamentals of Database Systems", 5th Edition by R. Elmasri and S. Navathe, Pearson Education	

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: 2024-28**	
Programme: B.Sc. (Hons.)		**Academic Year: 2025-26**	
Branch: Data Science & Analytics		**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. Murthy M.N. (1977): Sampling Theory & Statistical Methods, Statistical Pub. Society, Calcutta 2. Cochran W.G (1984): Sampling Techniques (3rd Ed.), Wiley Eastern.	
	Other References	1. Mukhopadhyay P. (1998): Theory and Methods of Survey Sampling, Prentice Hall 2. Guide to Current Indian Official Statistics, Central Statistical Organization, GOI, 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
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: 2024-28**	
Programme: B.Sc. (Hons.)		**Academic Year: 2025-26**	
Branch: Data Science & Analytics		**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 (Audit-Qualifying)	
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	1					1	1		
RBL002.2	2	3	3	2	1	1					1	1		
RBL002.3	2	2	2	3	1	1					1	1		
RBL002.4	2	3	2	2	1	1					1	1		
RBL002.5	3	3	2	2	1	1					1	1		
RBL002.6	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: 2024-28**	
Program: B.Sc. (Hons.)		**Academic Year: 2025-26**	
Branch: Data Science & Analytics		**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 resume, cover letters, interpret job descriptions and interpret KRA and KPI statements and art of conflict management. CO2: Build negotiation skills to get maximum benefits from deals in practical life scenarios. CO3: Develop skills of personal branding to create a brand image and self-branding CO4: Acquire higher level competency in use of logical and analytical reasoning such as direction sense, strong and weak arguments CO5: Develop higher level strategic thinking and diverse mathematical concepts through building analogies, odd one out CO6: Demonstrate higher level quantitative aptitude such as average, ratio & proportions, mixtures & allegation for making business decisions.	
7	Course Description	This penultimate stage introduces the student to the basics of Human Resources. Allows the student to understand and interpret KRA | KPI and understand Job descriptions. A student also understands how to manage conflicts, brand himself/herself, understand relations and empathise others with level-4 of quant, aptitude and logical reasoning	
8	Outline syllabus – ARP 306		
	Unit 1	**Ace the Interview**	**CO MAPPING**
	A	HR Sensitization (Role Clarity | KRA | KPI | Understanding JD) | Conflict Management	CO1
	B	Negotiation Skills | Personal Branding	CO3, CO4
	C	Uploading & Curating Resumes in Job Portals, getting Your Resumes Noticed | Writing Cover Letters | Relationship Management	CO1, CO3
	Unit 2	**Introduction to APTITUDE TRAINING- Reasoning- Logical/**	

		Analytical	
	A	Sitting Arrangement & Venn Diagrams | Puzzles | Distribution | Selection	CO4
	B	Direction Sense | Statement & Conclusion | Strong & Weak Arguments	CO4
	C	Analogies, Odd One out | Cause & Effect	CO5
	Unit 3	**Quantitative Aptitude**	
	A	Average , Ratio & Proportions, Mixtures & Allegation	CO6
	B	Geometry-Lines, Angles & Triangles	CO6
	C	Problem of Ages | Data Sufficiency - L2	CO6
	Unit 4	**Verbal Abilities-4**	
	A	Antonyms and Synonyms	CO1
	B	Idioms and Phrases	CO2
	Unit 5	**Problem Solving and Case Studies**	
	A	Real time Case Study Solving Exercises	CO4
	B	Intra student Mock Situation Handling Exercises	CO4
	Evaluation Weightage	(CA)Class Assignment/Free Speech Exercises / JAM – 60% | (ETE) Group Presentations/Mock Interviews(MIP's)/GD/ Reasoning, Quant & Aptitude– 40%	
	Text book/s*	Wiley's Quantitative Aptitude-P Anand | **Quantum CAT – Arihant Publications | Quicker Maths- M. Tyra** | Power of Positive Action (English, Paperback, Napoleon Hill) | Streets of Attitude (English, Paperback, Cary Fagan, Elizabeth Wilson) The 6 Pillars of self-esteem and awareness – Nathaniel Brandon | Goal Setting (English, Paperback, Wilson Dobson	

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

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

School: SSBSR		Batch: 2024-28	
Programme: B.Sc. (Hons.)		Academic Year: 2025-26	
Branch: Data Science & Analytics		Semester: IV	
1	Course Code	**BDA270**	
2	Course Title	**Data Ware Housing & Data Mining Lab**	
3	Credits	1	
4	Contact Hours (L-T-P)	0-0-2	
	Course Status	CC	
5	Course Objective	1. To introduce students to basic applications, concepts, and techniques of data mining. 2. To develop skills for using recent data mining software (eg. R) to solve practical problems in a variety of disciplines. 3. To gain experience doing independent study and research	
6	Course Outcomes	CO1: Learn how to build a data warehouse and query it (using open source tools like Pentaho Data Integration Tool, Pentaho Business Analytics). (K2, K5) CO2: Learn to perform data mining tasks using a data mining toolkit (such as open source WEKA). (K2) CO3: Understand the data sets and data preprocessing. (K2, K3) CO4: Demonstrate the working of algorithms for data mining tasks such association rule mining, classification, clustering and regression. (K2, K3) CO5: Exercise the data mining techniques with varied input values for different parameters. (K2, K5) CO6: To obtain Practical Experience Working with all real data sets. (K2, K5)	
7	Course Description	To introduce students to basic applications, concepts, and techniques of data mining. To develop skills for using recent data mining software to solve practical problems in a variety of disciplines. To gain experience doing independent study and research	
8	**Outline syllabus**		**CO Mapping**
	Unit 1	**Lab. Experiment 1**	
	A, B, C	Installation of WEKA Tool Creating new Arff File	CO1
	Unit 2	**Lab. Experiment 2**	
	A, B, C	Pre-Processes Techniques on Data Set Pre-process a given dataset based on Handling Missing Values	CO2
	Unit 3	**Lab. Experiment 3**	
	A, B, C	Generate Association Rules using the Apriori Algorithm Generating association rules using fp growth algorithm	CO3
	Unit 4	**Lab. Experiment 4**	
	A, B, C	Build a Decision Tree by using J48 algorithm Naïve bayes classification on a given data set	CO4
	Unit 5	**Lab. Experiment 5**	
	A, B, C	Applying k-means clustering on a given data set. Calculating Information gains measurs OLAP Cube and its different operations	CO5, CO6
	Mode of examination	Practical+Viva	
	Weightage Distribution	CA:25%; CE:25%; ESE:50%	

	Text book/s*	1.Jiawei Han and M Kamber , Data Mining Concepts and Techniques, , Second Edition, Elsevier Publication.	
	Other Reference s	1. Arun K. Pujari, Data Mining Techniques, University Press. 2. Vipin Kumar, Introduction to Data Mining Pang Ning Tan, Michael Steinbach, Addison 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
BDA270.1	1	2	2	2	2	1	1	3	1	1	2	1	2	2
BDA270.2	1	2	3	2	2	1	1	3	1	1	2	1	2	2
BDA270.3	1	2	2	2	2	1	1	3	1	1	2	1	2	2
BDA270.4	1	2	2	2	2	1	1	3	1	1	2	1	2	2
BDA270.5	1	2	2	2	2	1	1	3	1	1	2	1	2	2
BDA270.6	1	2	2	2	2	1	1	3	1	1	2	1	2	2
Average	**1.0**	**2.0**	**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: 2024-28**	
Programme: B.Sc. (Hons.)		**Academic Year: 2025-26**	
Branch: Data Science & Analytics		**Semester: IV**	
1	Course Code	**BDA271**	
2	Course Title	**Database Management Systems Lab**	
3	Credits	1	
4	Contact Hours (L-T-P)	0-0-2	
	Course Status	CC	
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.	CO1, 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.	CO1, 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. 2. How to Solve it by Computer", 2nd Impression by R. G. Dromey, Pearson Education.	

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	
BDA271.2	1	2	3	2		1	1	3	1		2		2	
BDA271.3	1	2	2	2		1	1	3	1		2		2	
BDA271.4	1	2	2	2		1	1	3	1		2		2	
BDA271.5	1	2	2	2		1	1	3	1		2		2	
BDA271.6	1	2	2	2		1	1	3	1		2		2	
Average	**1.0**	**2.0**	**2.0**	**2.0**		**1.0**	**1.0**	**3.0**	**1.0**		**2.0**		**2.0**	

School: SSBSR		**Batch: 2024-28**	
Programme: B.Sc. (Hons.)		**Academic Year: 2025-26**	
Branch: Data Science & Analytics		**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	CO1,CO5
	Unit 5	**Lab. Experiment 5**	
	A, B, C	Problem-based on ratio and regression type estimator.	CO1, CO6
	Mode of examination	Practical+Viva	
	Weightage Distribution	CA: 25%; CE:25%; ETE:75%	
	Text book/s*	1. Murthy M.N. (1977): Sampling Theory & Statistical Methods, Statistical Pub. Society, Calcutta 2. Cochran W.G (1984): Sampling Techniques (3rd Ed.), Wiley Eastern.	

	Other References	1. Mukhopadhyay P. (1998): Theory and Methods of Survey Sampling, Prentice Hall 2. Guide to current Indian Official Statistics, Central Statistical Organization, GOI, 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
BDA272.1	1	2	2	2	1	1	1	3	1		2	1		
BDA272.2	1	2	3	2	1	1	1	3	1		2	1		
BDA272.3	1	2	2	2	1	1	1	3	1		2	1		
BDA272.4	1	2	2	2	1	1	1	3	1		2	1		
BDA272.5	1	2	2	2	1	1	1	3	1		2	1		
BDA272.6	1	2	2	2	1	1	1	3	1		2	1		
Average	**1.0**	**2.0**	**2.0**	**2.0**	**1.0**	**1.0**	**1.0**	**3.0**	**1.0**		**2.0**	**1.0**		

Detailed Syllabus for

DEGREE IN

DATA SCIENCE & ANALYTICS

School: SSBSR		**Batch: 2024-28**	
Programme: B.Sc. (Hons.)		**Academic Year: 2026-27**	
Branch: Data Science & Analytics		**Semester: V**	
1	Course Code	**BDA346**	
2	Course Title	**Artificial Intelligence**	
3	Credits	5	
4	Contact Hours (L-T-P)	5-0-0	
	Course Status	CC	
5	Course Objective	The objective of this course is to help students to learn the application of machine learning /A. I have algorithms in the different fields of science, medicine, finance, etc.	
6	Course Outcomes	CO1: Understand basic concepts and applications of machine learning (K1, K3, K4). CO2: Able to predicate logic and transform real-life information into a different representation. (K3, K6). CO3: Analyze the state space and its searching strategies. (K2, K5). CO4: Able to apply machine learning concepts and a range of problems that can be handled by machine learning. (K2, K3, K4). CO5: Analyze problem specifications and derive appropriate solution techniques for them and also design and implement appropriate solutions for search problems and planning problems. (K4, K6). CO6: Enable students to apply the machine learning concepts to real-life problems. (K5, K6)	
7	Course Description	This course aims to introduce the fundamental concepts of Artificial Intelligence to students. The course will explain various important concepts such as searching techniques, Knowledge representation, Uncertainty, and Natural Language Processing.	
8	**Outline syllabus**		**CO Mapping**
	Unit 1		
	A	Overview of AI problems, AI problems as NP, NP-Complete, and NP-Hard problems.	CO1
	B	Strong and weak, neat and scruffy, symbolic and sub-symbolic, knowledge-based and data-driven AI.	CO1
	C	Search Strategies: Problem spaces (states, goals, and operators), problem-solving by search, Heuristics, and informed search, Minmax Search, Alpha-beta pruning.	CO1
	Unit 2		CO2
	A	Constraint satisfaction (backtracking and local search methods).	CO2
	B	Knowledge representation and reasoning: propositional and predicate logic, Resolution and theorem proving Temporal and spatial reasoning.	CO2
	C	Probabilistic reasoning, Bayes theorem.	
	Unit 3		CO3
	A	Totally-ordered and partially-ordered Planning.	CO3
	B	Goal stack planning, Nonlinear planning, Hierarchical planning.	CO4
	C	Learning: Learning by example, learning by advice, Explanation based learning, Learning in problem-solving, Classification, Inductive learning, Naive Bayesian Classifier, and decision trees.	
	Unit 4		CO5

	A	Natural Language Processing: Language models, n-grams, Vector space models, Bag of words, Text classification. Information retrieval.	CO5
	B	Agents: Definition of agents, Agent architectures (e.g., reactive, layered, cognitive).	CO5
	C	Multi-agent systems-Collaborating agents, Competitive agents, Swarm systems and biologically inspired models.	
	Unit 5	Intelligent Systems: Representing and Using Domain Knowledge, Expert System Shells, Explanation, Knowledge Acquisition.	CO6
	A	Key Application Areas: Expert system, decision support systems.	CO6
	B	Speech and vision, Natural language processing, Information Retrieval, Semantic Web.	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. Artificial Intelligence Elaine Rich, Kevin Knight, and Shivashankar B Nair, Tata McGraw Hill.	
	Other References	1. Introduction to Artificial Intelligence and Expert Systems by Dan W. Patterson, Pearson Education. 2. Artificial Intelligence: A Modern Approach by S. Russell and P. Norvig, Prentice Hall.	

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**
BDA346.1	3	3	2	2		1					3	3		
BDA346.2	2	3	3	2		1					3	3		
BDA346.3	2	2	2	3		1					3	3		
BDA346.4	2	3	2	2		1					3	3		
BDA346.5	3	3	2	2		1					3	3		
BDA346.6	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: 2024-28**	
Programme: B.Sc. (Hons.)		**Academic Year: 2026-27**	
Branch: Data Science & Analytics		**Semester: V**	
1	Course Code	**BDA303**	
2	Course Title	**Machine learning**	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
	Course Status	CC	
5	Course Objective	The objective of this course is to introduce machine learning fundamentals to students.	
6	Course Outcomes	CO1: Recognize the characteristics of machine learning that make it useful to real-world problems (K2, K3) CO2: Characterize machine learning algorithms as supervised, semi-supervised, and unsupervised (K2, K3) CO3: Design and implement machine learning solutions to classification, regression, and clustering problems (K3, K6). CO4: Be able to evaluate and interpret the results of the algorithms (K4, K5) CO5: Effectively use machine learning toolboxes (K5). CO6: Ability to recognize and implement various ways of selecting suitable model parameters for different machine learning techniques. Ability to integrate deep learning libraries and mathematical and statistical tools (K4, K5).	
7	Course Description	This course provides introductory concepts of various machine learning techniques to students which will help to build the foundation for further understanding. This course also aims to provide details of various steps involved in the machine learning pipeline such as data collection, pre-processing, feature engineering, etc. This course also introduces popular tools used in the area of machine learning. This course mainly focused on Regression and Neural network-based Machine learning algorithms.	
8	**Outline syllabus**		**CO Mapping**
	Unit 1	**Introduction to Machine Learning**	
	A	Machine Learning Fundamentals –Types of Machine Learning - Supervised, Unsupervised, Reinforcement- The Machine Learning process.	CO1
	B	Terminologies in ML- Testing ML algorithms: Over fitting, Training, Testing and Validation Sets-Confusion matrix -Accuracy metrics- ROC Curve.	CO1
	C	Basic Statistics: Averages, Variance and Covariance, The Gaussian- The Bias-Variance trade off- Applications of Machine Learning.	CO1
	Unit 2		
	A	Regression: Linear Regression – Multivariate Regression analysis, Linear Basis Function Models, The Bias-Variance Decomposition, Bayesian Linear Regression	CO2
	B	Classification: Linear Discriminant Analysis, Logistic Regression- K-Nearest Neighbor classifier.	CO2
	C	Decision Tree based methods for classification and Regression- Ensemble methods.	CO2
	Unit 3		
	A	Clustering- K-Means clustering, Hierarchical clustering.	CO3
	B	The Curse of Dimensionality –Dimensionality Reduction - Principal Component Analysis - Probabilistic PCA- Independent Components	CO3

		analysis	
	C	The Internet, Business and Retail, Law Enforcement, Computing, Clustering models: How the K-means and PCA works, Calculating the number of clusters in a dataset.	CO3
	Unit 4		
	A	Perceptron- Multilayer perceptron- Back Propagation- Initialization, Training and Validation Support.	CO4
	B	Vector Machines (SVM) as a linear and non-linear classifier - Limitations of SVM	CO4
	C	Recognition of MNIST handwritten digits using Artificial Neural Network. Build an email spam classifier using SVM.	CO4
	Unit 5		
	A	Bayesian Networks - Learning Naive Bayes classifiers-Markov Models – Hidden Markov Models.	CO5
	B	Sampling – Basic sampling methods – Monte Carlo -Reinforcement Learning.	CO5
	C	Classify the given text segment as 'Positive' or 'Negative' statement using the Naive Bayes Classifier. Predict future stock price of a company using Monte Carlo Simulation.	CO6
	Mode of examination	Theory	
	Weightage Distribution	CA:25%; ESE:75%	
	Text book/s*	1. Mitchell Tom, Machine Learning. McGraw Hill. 2. Dr. Nilesh Shelke, Dr. Gopal Sakarkar, Dr N V Choudhari, Introduction to Machine Learning, Ganu Prakashan.	
	Other References	1. Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements of Statistical Learning Data Mining, Inference, and Prediction 2. Andreas C. Muller, "Introduction to Machine Learning with Python: A Guide for Data Scientists", O'Reilly	

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
BDA303.1	3	3	2	2		1					3	3		
BDA303.2	2	3	3	2		1					3	3		
BDA303.3	2	2	2	3		1					3	3		
BDA303.4	2	3	2	2		1					3	3		
BDA303.5	3	3	2	2		1					3	3		
BDA303.6	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: 2024-28**	
Programme: B.Sc. (Hons.)		**Academic Year: 2026-27**	
Branch: Data Science & Analytics		**Semester: V**	
1	Course Code	**BDA319**	
2	Course Title	**Regression Analysis**	
3	Credits	3	
4	Contact Hours (L-T-P)	3-0-0	
	Course Status	CC	
5	Course Objective	The main objective of this course is to demonstrate and intended to verse students in the techniques necessary to understand and carry out regression and predictive analysis.	
6	Course Outcomes	At the end of the course, the student should be able to CO1: Explain the concept of regression with two and multiple variables. CO2: Testing of the single and subset of the regression coefficient. CO3: Explain the concept of multicollinearity. CO4: Describe how to overcome the problem of heteroscedasticity and autocorrelation. CO5: Explain the concept of dummy variables. CO6: How to apply logistic regression on a dataset.	
7	Course Description	A PG-level course in regression analysis, intended to verse students in the techniques necessary to understand and carry out methods of research in serial analysis. Lectures study the large-sample properties of estimators based on one-sample, k-sample, and partial likelihood inference, with proofs based on the 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			
	Unit 1		
	A	Simple Linear Regression: Simple linear regression model. Least-squares estimation of parameters. Hypothesis testing on the slope and intercept. Interval estimation in simple linear regression.	CO1
	B	Prediction of new observations. Coefficient of determination. Estimation by maximum likelihood.	CO1
	C	Multiple linear regression: Multiple linear regression models. Estimation of the model parameters. Hypothesis testing in multiple linear regression. Confidence intervals in multiple regression. Coefficient of determination and Adjusted R2.	CO1
	Unit 2		CO2
	A	Logistic Regression: Introduction, Linear predictor and link functions, logit, probit, odds ratio, the test of hypothesis. Discriminant Analysis.	CO2
	B	Model Adequacy: Checking of linearity between study and explanatory variable, Residual Analysis, Detection and treatment of outliers, Residual plots.	CO2
	C	The PRESS statistic. Outlier test based on Studentized Residual (R-student). Test for lack of fit of the regression model.	
	Unit 3		CO3
	A	Data Understanding and Preparation Introduction, Reading data from various sources, Data visualization, Distributions, and summary statistics, Relationships among variables	CO3

	B	The extent of Missing Data. Segmentation, Outlier detection, Automated Data Preparation	CO3
	C	Combining data files, Aggregate Data, Duplicate Removal, Sampling DATA, Data Caching, Partitioning data, and Missing Values.	
	Unit 4		CO4
	A	Model development & techniques Data Partitioning, Model selection, Model Development Techniques	CO4
	B	Neural networks, Decision trees, Logistic regression, Discriminant analysis, Support vector machine	CO4
	C	Bayesian Networks, Linear Regression, Cox Regression, and Association rules.	
	Unit 5		CO5
	A	Model Evaluation and Deployment Introduction, Model Validation, Rule Induction Using CHAID	CO5
	B	Automating Models for Categorical and Continuous targets, Comparing and Combining Models, and Evaluation Charts for Model Comparison	CO5, CO6
	C	Meta Level Modeling, Deploying Model, Assessing Model Performance, Updating a Model.	
	Mode of examination	Theory	
	Weightage Distribution	CA:25%; ESE:75%	
	Text book/s*	1. Johnston, J. (1984). Econometric Methods, McGraw Hill Kogakusha Ltd.	
	Other References	1. Draper, N. R., and Smith, H. (1998). Applied Regression Analysis (John Wiley) Third 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**
BDA319.1	3	3	2	2	1	1					3	3		
BDA319.2	2	3	3	2	1	1					3	3		
BDA319.3	2	2	2	3	1	1					3	3		
BDA319.4	2	3	2	2	1	1					3	3		
BDA319.5	3	3	2	2	1	1					3	3		
BDA319.6	3	3	2	3	1	1					3	3		
Average	**2.3**	**2.6**	**2.0**	**2.1**	**1.0**	**1.0**					**3.0**	**3.0**		

School: SSBSR		**Batch: 2024-28**	
Programme: B.Sc. (Hons.)		**Academic Year: 2026-27**	
Branch: Data Science & Analytics		**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 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			
	Unit 1		
	A	Use of discrete distribution (Uniform, Binomial, and Poisson) in real-life problems.	CO1, CO6
	B	Use of continuous distribution (Normal, Exponential, and Gamma) in real-life problems.	CO1, CO6
	C	Its applications in Industrial work.	CO1, CO6
	Unit 2		
	A	Sampling Distributions.	CO2, CO6
	B	$\chi 2$ distribution properties and Interrelationships.	CO2, CO6
	C	t distribution properties and Interrelationships.	CO2, CO6
	Unit 3		
	A	F distribution properties.	CO3, CO6
	B	Interrelationship of $\chi 2$, 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. Gupta. S.C. & Kapoor, V.K. (2002): Fundamentals of Mathematical Statistics, Sultan Chand & Sons. 2. 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.. 2. Mukhopadhyay P. (1999): Applied Statistics, Books and Allied 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			3	3	1	
BDA320.2		2	1	2		1		3			3	3	1	
BDA320.3		2	1	2		1		3			3	3	1	
BDA320.4		2	1	2		1		3			3	3	1	
BDA320.5		2	1	2		1		3			3	3	1	
BDA320.6		2	1	2		1		3			3	3	1	
Average		**2.0**	**1.0**	**2.0**		**1.0**		**3.0**			**3.0**	**3.0**	**1.0**	

School: SSBSR		**Batch: 2024-28**	
Programme: B.Sc. (Hons.)		**Academic Year: 2026-27**	
Branch: Data Science & Analytics		**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			
	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

	B	Missing plot technique and its application to RCBD, LSD. Cross-over design. Sampling in field experiments.	CO5
	C	Transformation of data. Response surfaces. Experiments with mixtures.	CO6
	Mode of examination	Theory	
	Weightage Distribution	CA:25%; ESE:75%	
	Text book/s*	1. Gupta. S.C. & Kapoor, V.K.: Fundamentals of Mathematical Statistics, Sultan Chand & Sons Pvt. Ltd. New Delhi. 2. Westfall, P., & Henning, K. S.: Understanding Advanced Statistical Methods. CRC Press.	
	Other References	1.Cochran, Wigand Cox, G.M. Experimental Designs. John Wiley and Sons. 2.Das, M.N. and Giri, Design and Analysis of Experiments. New Age International.	

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			1	1		
BDA321.2		2	1	2		1		3			1	1		
BDA321.3		2	1	2		1		3			1	1		
BDA321.4		2	1	2		1		3			1	1		
BDA321.5		2	1	2		1		3			1	1		
BDA321.6		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: 2024-28**	
Programme: B.Sc. (Hons.)		**Academic Year: 2026-27**	
Branch: Data Science & Analytics		**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	2	1		3			2	2	2	2
RBL003.2		2	1	2	2	1		3			2	2	2	2
RBL003.3		2	1	2	2	1		3			2	2	2	2
RBL003.4		2	1	2	2	1		3			2	2	2	2
RBL003.5		2	1	2	2	1		3			2	2	2	2
RBL003.6		2	1	2	2	1		3			2	2	2	2
Average		**2.0**	**1.0**	**2.0**	**2.0**	**1.0**		**3.0**			**2.0**	**2.0**	**2.0**	**2.0**

School: SSBSR		**Batch: 2024-28**	
Programme: B.Sc. (Hons.)		**Academic Year: 2026-27**	
Branch: Data Science & Analytics		**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,CO6
	Unit 2		
	A, B, C	Problem Definition and identification, Team/Group formation, and Project Assignment. Finalizing the problem statement, and resource requirement, if any.	CO2,CO6,
	Unit 3		
	A, B, C	The internship work plan is drawn up by developing teamwork and applying prior acquired knowledge in problem-solving.	CO3,CO6,
	Unit 4		
	A, B, C	Demonstrate and execute Project with the team. Submission of the evaluation form and final report completed by the intern.	CO4,CO6
	Unit 5		
	A, B, C	Final evaluation form completed by the supervisor at the Host Organization and final presentation before the departmental committee.	CO5,CO6
	Mode of examination		
	Weightage Distribution		
	Text book/s*		

	Other References		

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

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

School: SSBSR		**Batch: 2024-28**	
Programme: B.Sc. (Hons.)		**Academic Year: 2026-27**	
Branch: Data Science & Analytics		**Semester: V**	
1	Course Code	**BDA355**	
2	Course Title	**Machine Learning 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 Machine Learning algorithms. 2. Make use of Data sets in implementing the machine learning algorithms. Implement the machine learning concepts and algorithms in any suitable language of choice.	
6	Course Outcomes	CO1: Show the implementation of linear and logistic Regression on real life applications. CO2: Interpretation of existing models to understand the solution environment. CO3: Application of existing mathematical solutions to test real world problems. CO4: Analyse the logical ability to apply clustering approach to extract hierarchical patterns existing in real life problems. CO5: Build the understanding of learning theory to glance the upcoming world through it. CO6: Appraise recent trends in machine learning and applications	
7	Course Description	This course introduces computational learning paradigm for critical & implementable understanding for supervised and unsupervised learning based problem areas.	
8	**Outline syllabus**		**CO Mapping**
	Unit 1		CO1
	A, B, C	Write a Program to load and view data set file.	CO1, CO6
		Write a program to implement simple linear regression using housing price prediction problem.	
		Write a program to implement binary logistic regression using cancer identification problem.	
	Unit 2		
	A, B, C	Write a program to implement gradient descent method for learning.	CO1, CO2
		Write a program to implement regularized linear regression.	
		Write a program to implement regularized logistic regression.	
		Write a program to Normalize the data used in linear regression problem above before predicting prices, and then predict the housing prices.	
	Unit 3		
	A, B, C	Write a program to implement Support Vector Machine regression using suitable dataset.	CO1, CO2, CO6
		Build an Artificial Neural Network by implementing the Backpropagation algorithm and test the same using appropriate data sets.	
		Write a program to demonstrate the working of the decision tree based ID3 algorithm. Use an appropriate data set for building the decision tree and apply this knowledge to classify a new sample.	
		Write a program to demonstrate the working of the Random Forest algorithm. Use an appropriate data set for classifying a new sample.	

	Unit 4		
	A, B, C	Write a program to implement K-Means clustering algorithm using an appropriate dataset.	CO2, CO3, CO4
		Write a program to implement K-Means clustering algorithm using an appropriate dataset	
	Unit 5		
	A, B, C	Write a program to implement data split into training, cross validation and testing data.	CO4, CO5, CO6
		Implement an Ensemble approach by combining different models to solve time series based prediction problem.	
		Conduct hypothesis testing using some statistical toolkit on appropriate problem.	
	Mode of examination	Practical+Viva	
	Weightage Distribution	CA:25%; CE:25%; ESE:50%	
	Text book/s*	1. Bishop, C.: Pattern Recognition and Machine Learning. Berlin: Springer-Verlag. 2. Ethem Alpaydin: Introduction to Machine Learning, 3rd Edition	
	Other References	1. Baldi, P. and Brunak, S. (2002). Bioinformatics: A Machine Learning Approach. Cambridge, MA: MIT Press. 2. https://www.toptal.com/machine-learning/ensemble-methodsmachine-learning.	

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
BDA355.1	1	2	2	2	2	1	1	3	1	2	3	2	2	3
BDA355.2	1	2	3	2	2	1	1	3	1	2	3	2	2	3
BDA355.3	1	2	2	2	2	1	1	3	1	2	3	2	2	3
BDA355.4	1	2	2	2	2	1	1	3	1	2	3	2	2	3
BDA355.5	1	2	2	2	2	1	1	3	1	2	3	2	2	3
BDA355.6	1	2	2	2	2	1	1	3	1	2	3	2	2	3
Average	**1.0**	**2.0**	**2.0**	**2.0**	**2.0**	**1.0**	**1.0**	**3.0**	**1.0**	**2.0**	**3.0**	**2.0**	**2.0**	**3.0**

School: SSBSR		**Batch: 2024-28**	
Programme: B.Sc. (Hons.)		**Academic Year: 2026-27**	
Branch: Data Science & Analytics		**Semester: V**	
1	Course Code	**BDA356**	
2	Course Title	**Regression Analysis Lab**	
3	Credits	1	
4	Contact Hours (L-T-P)	0-0-2	
	Course Status	CC	
5	Course Objective	After studying these courses students will be able to understand how to calculate the power of the test, analyze the multivariate data and understand the characteristics of multivariate quantitative research, including strengths and weaknesses. It also discusses the principles and characteristics of the multivariate data analysis techniques.	
6	Course Outcomes	At the end of the course, the student should be able to CO1: Estimate the parameter by MLE CO2: Learn about how to calculate the Rao, Lehman, and Bhattacharya bounds CO3: Learn how to calculate the critical region, power of the test, unbiased test, and Neyman structure. CO4: Understand the basic concepts of multivariate normal distribution. CO5: Calculate Wishart distribution in the multivariate analysis also know how to find Mahalanobis D2 and HottelingT2. CO6: Apply the classification rule, PCA, and factor analysis.	
7	Course Description	In this course, students are concerned with making inferences based on relations found in the sample, to relations in the population. Also multivariate analysis of data deals with examining the interrelationship between three or more equally important variables or explaining variation in, usually one (or more than one) dependent variable(s) based on two or more independent (explaining) variables.	
8	**Outline syllabus**		**CO Mapping**
	Unit 1		
	A, B, C	Problem-based on Multiple regression analysis python using R/Python.	CO1 CO2
	Unit 2		
	A, B, C	Problem-based on Logistic regression analysis python using R/Python.	CO2, CO3
	Unit 3		
	A, B, C	Problem-based on Discriminant Analysis using R/Python.	CO3, CO4
	Unit 4		
	A, B, C	Problem-based on Multivariate Analysis of Variance and Covariance using R/Python.	CO4,CO5
	Unit 5		
	A, B, C	Problem-based on classification rule, PCA, and factor analysis using R/Python.	CO5, CO6
	Mode of examination	Practical+Viva	
	Weightage Distribution	CA:25%; CE:25%; ESE:50%	
	Text book/s*	1.Johnston, J. (1984). Econometric Methods, McGraw Hill Kogakusha Ltd.	

	Other References	2. Draper, N. R., and Smith, H. (1998). Applied Regression Analysis (John Wiley) Third 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
BDA356.1	1	2	2	2	2	1	1	3	1	2	2	2	2	3
BDA356.2	1	2	3	2	2	1	1	3	1	2	2	2	2	3
BDA356.3	1	2	2	2	2	1	1	3	1	2	2	2	2	3
BDA356.4	1	2	2	2	2	1	1	3	1	2	2	2	2	3
BDA356.5	1	2	2	2	2	1	1	3	1	2	2	2	2	3
BDA356.6	1	2	2	2	2	1	1	3	1	2	2	2	2	3
Average	**1.0**	**2.0**	**2.0**	**2.0**	**2.0**	**1.0**	**1.0**	**3.0**	**1.0**	**2.0**	**2.0**	**2.0**	**2.0**	**3.0**

School: SSBSR		**Batch: 2024-28**	
Programme: B.Sc. (Hons.)		**Academic Year: 2026-27**	
Branch: Data Science & Analytics		**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: 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 situations. (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	**Outline syllabus**		**CO Mapping**
	Unit 1	**Lab. Experiment 1:**	
	A, B, C	Real life Problem Based on Discrete Probability Distributions (Uniform, Binomial and Poisson) Using Python Real life problem based on Continuous Probability Distributions (Normal, Exponential and Gamma) using python.	CO1, CO2
	Unit 2	**Lab. Experiment 2:**	
	A, B, C	Real life Problem based on sampling Distribution (t-test and z test) using python. Real life Problem based on Sampling Distribution (F, Chi-Square) using python.	CO2, CO3
	Unit 3	**Lab. Experiment 3:**	
	A, B, C	Real life Problem based on ANOVA (One Way) using python. Real life Problem based on ANOVA (Two Way) using python.	CO3, CO4
	Unit 4	**Lab. Experiment 4:**	
	A, B, C	Real life Problem Based on Principle Component Analysis (PCA) in Python. Real life Problem Based on Factor Analysis in Python.	CO4, CO5, CO6
	Unit 5	**Lab. Experiment 5:**	
	A, B, C	Real life Problem Based on Cluster in Python. Real life problem based on Point Estimation and Interval. Estimation using Python..	CO5, CO6

	Mode of examination	Practical+Viva	
	Weightage Distribution	CA:25%; CE:25%; ESE:50%	
	Text book/s*	1. Gupta. S.C. & Kapoor, V.K. (2002): Fundamentals of Mathematical Statistics, Sultan Chand & Sons. 2. 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. 2. Mukhopadhyay P. (1999): Applied Statistics, Books and Allied 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
BDA359.1	1	2	2	2	1	1	1	3	1	1	3	1	2	3
BDA359.2	1	2	3	2	1	1	1	3	1	1	3	1	2	3
BDA359.3	1	2	2	2	1	1	1	3	1	1	3	1	2	3
BDA359.4	1	2	2	2	1	1	1	3	1	1	3	1	2	3
BDA359.5	1	2	2	2	1	1	1	3	1	1	3	1	2	3
BDA359.6	1	2	2	2	1	1	1	3	1	1	3	1	2	3
Average	**1.0**	**2.0**	**2.0**	**2.0**	**1.0**	**1.0**	**1.0**	**3.0**	**1.0**	**1.0**	**3.0**	**1.0**	**2.0**	**3.0**

School: SSBSR		**Batch: 2024-28**	
Programme: B.Sc. (Hons.)		**Academic Year: 2026-27**	
Branch: Data Science & Analytics		**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		CO1
	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. Gupta. S.C. & Kapoor, V.K.: Fundamentals of Mathematical Statistics, Sultan Chand & Sons Pvt. Ltd. New Delhi. 2. Westfall, P., & Henning, K. S.: Understanding Advanced Statistical Methods. CRC Press.	
	Other References	1.Cochran, Wigand Cox, G.M. Experimental Designs. John Wiley and Sons. 2.Das, M.N. and Giri, Design and Analysis of Experiments. New Age International.	

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: 2024-28**	
Programme: B.Sc. (Hons.)		**Academic Year: 2026-27**	
Branch: Data Science & Analytics		**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	Compulsory	
5	Course Objective	1. To provide the student with numerical methods of solving the non-linear equations, interpolation, differentiation, and integration. 2. To improve the student's skills in numerical methods by using the MATLAB.	
6	Course Outcomes	The student will be able to: CO1:Solve a linear system of equations using an appropriation method and develop the algorithm in MATLAB. (K1,K3,K5,K6) CO2: Solve the algebraic or transcendental equations using numerical methods and develop the algorithm in MATLAB. (K1,K3,K5,K6) CO3: Discuss the finite difference methods to analyse the functions (K2,K4) CO4: Explain the divided difference and evaluate the function. (K2, K4, K5) CO5:Describe the numerical differentiation and evaluate the differentiation. (K1, K2, K5) CO6: Calculate a definite integral using an appropriation method and develop the algorithm in MATLAB. (K1,K3,K5,K6)	
7	Course Description	This course is an introduction to the numerical analysis. The primary objective of the course is to develop the basic understanding of numerical algorithms and skills to implement algorithms to solve mathematical problems in MATLAB..	
8	**Outline syllabus**		**CO Mapping**
	Unit 1	**Solution of system of linear equations:**	
	A	Direct methods: Cramer's rule, Matrix inverse method	CO1
	B	Gauss elimination and Gauss-Jordan method	CO1
	C	Iterative methods: Jacobi's method, Gauss-Seidal method	CO1
	Unit 2	**System of Transcendental equations:**	
	A	Initial approximation of the roots, Bisection method, Method of false position	CO2
	B	Secant method, iteration method,	CO2
	C	Newton-Raphson method and its convergence.	CO2
	Unit 3	**Finite differences and Interpolation**	
	A	Finite difference operators, their properties and their interrelations, finite difference tables.	CO3
	B	Newton's forward and Newton's backward interpolation formula	CO3
	C	Central difference formulae including Stirling's formula, Bessel's formula.	CO3
	Unit 4	**Divided differences**	
	A	Operators and difference table	CO4
	B	Newton's divided difference formula	CO4

	C	Lagrange's interpolation formula.	CO4
	Unit 5	**Numerical differentiation and integration**	
	A	Differentiation using Newton's forward and backward formula	CO5
	B	Newton-Cotes Quadrature formula -derivations & comparison of Trapezoidal rule	CO6
	C	Simpson's 1/3 and 3/8 rules.	CO6
	Mode of examination	Theory	
	Weightage Distribution	CA:25%; ESE:75%	
	Text book/s*	1.EndreSuli, David F. Mayers: An Introduction to Numerical Analysis. Cambridge University Press. 2.Gupta, R.S.: Elements of Numerical Analysis Macmillan India Ltd.	
	Other References	1. Grewal, B.S. Numerical methods in Engineering & Science Khanna Publishers.	

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	2	2	2	1					2			
CMS331.2	2	2	2	2	2	1					2			
CMS331.3	3	3	3	3	2	1					2			
CMS331.4	2	2	2	3	2	1					2			
CMS331.5	2	3	3	3	2	1					2			
CMS331.6	3	2	3	3	2	1					2			
Average	**2.5**	**2.5**	**2.5**	**2.6**	**2.0**	**1.0**					**2.0**			

School: SSBSR		**Batch: 2024-28**	
Programme: B.Sc. (Hons.)		**Academic Year: 2026-27**	
Branch: Data Science & Analytics		**Semester: VI**	
1	Course Code	**BDA322**	
2	Course Title	**Statistical Simulation**	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
	Course Status	CC	
5	Course Objective	The learning objectives include: Concept of simulation and simulation modeling, Generation of Pseudo random number generators as well as from standard statistical distributions, Monte-Carlo simulation technique and application of simulation techniques.	
6	Course Outcomes	CO1: Recognize the concepts of probability and statistics that are relevant to modeling and simulation (K2, K3). CO2: How to generate random numbers by the different methods (K2, K3). CO3: Design and implement Bootstrapping; jackknife resampling(K3, K4). CO4: Be able to evaluate and interpret the Markov-Chain Monte Carlo (MCMC) simulations (K3, K4). CO5: Hands-on experience in using simulation software packages/structured programming languages (K3, K4, K5) CO6: How simulation may be used to understand the behavior of real world systems by utilizing mathematical models with an emphasis on simulation (K4, K6).	
7	Course Description	The course topics will include a review of concepts from probability and statistics that are relevant to modeling and simulation, algorithms for random-variable sampling, modeling and analysis of basic queueing systems, variance-reduction techniques, statistical-validation techniques, Independent Monte Carlo (IMC) and Markov-Chain Monte Carlo (MCMC) simulations, and discrete-event modeling and simulation.	
8	**Outline syllabus**		**CO Mapping**
	Unit 1		
	A	Review of R/Python.	CO1
	B	Random number generation: Inverse-transform; acceptance-rejection; transformations.	CO1
	C	Statistic simulations: generating random variables, simulating normal, gamma and beta random variables.	CO1
	Unit 2		
	A	Simulating multivariate distributions, MCMC methods.	CO2
	B	Gibbs sampler, simulating random fields, simulating stochastic process.	CO2
	C	Variance reduction technique: importance sampling for integration, control variates and antithetic variables.	CO2
	Unit 3		
	A	Bootstrapping; jackknife resampling.	CO3
	B	Bootstrapping for estimation of sampling distribution. Confidence intervals, variance stabilizing transformation.	CO3
	C	Bootstrapping in regression and sampling from finite populations.	CO3

	Unit 4		
	A	Simulating a non-homogeneous Poisson process.	CO4
	B	Optimization using Monte Carlo methods simulated annealing for optimization.	CO4
	C	Solving differential equations by Monte Carlo methods.	CO4
	Unit 5		
	A	Univariate density estimation; kernel smoothing multivariate density estimation	CO5, CO6
	B	Root finding; more on numerical integration; numerical maximization/minimization; constrained and unconstrained optimization.	CO5, CO6
	C	EM (Expectation-Maximization) algorithm; simplex algorithm.	CO5, CO6
	Mode of examination	Theory	
	Weightage Distribution	CA:25%; ESE:75%	
	Text book/s*	1. Fishman, G.S. Monte Carlo: Concepts, Algorithms and Applications. 2. Rubinstein, R.Y.: Simulation and the Monte Carlo Method.	
	Other References	1. Ross, S. M.: Simulation, Third Edition, Academic Press. 2. Efron, B. and Tibshirani. R.J.: An introduction to the Bootstrap.	

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**
BDA322.1	3	3	2	2	2	1					2	2		
BDA322.2	2	3	3	2	2	1					2	2		
BDA322.3	2	2	2	3	2	1					2	2		
BDA322.4	2	3	2	2	2	1					2	2		
BDA322.5	3	3	2	2	2	1					2	2		
BDA322.6	3	3	2	3	2	1					2	2		
Average	**2.3**	**2.6**	**2.0**	**2.1**	**2.0**	**1.0**					**2.0**	**2.0**		

School: SSBSR		**Batch: 2024-28**	
Programme: B.Sc. (Hons.)		**Academic Year: 2026-27**	
Branch: Data Science & Analytics		**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.: Applied Multivariate Statistical Analysis, Sixth Edition, Pearson Education India. 2. Hardle, W.K. and Hlavka, Z. Multivariate Statistics, Springer.	
	Other References	1. Anderson, T.W.: An Introduction to Multivariate Statistical Analysis, Third Edition, Wiley. 2. Härdle, W.K. and Simar, L. : Applied Multivariate Statistical Analysis, 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	PO 11	PSO 1	PSO 2	PSO 3
BDA323.1	3	3	2	2	2	1					2	2		
BDA323.2	2	3	3	2	2	1					2	2		
BDA323.3	2	2	2	3	2	1					2	2		
BDA323.4	2	3	2	2	2	1					2	2		
BDA323.5	3	3	2	2	2	1					2	2		
BDA323.6	3	3	2	3	2	1					2	2		
Average	**2.3**	**2.6**	**2.0**	**2.1**	**2.0**	**1.0**					**2.0**	**2.0**		

School: SSBSR		**Batch: 2024-28**	
Programme: B.Sc. (Hons.)		**Academic Year: 2026-27**	
Branch: Data Science & Analytics		**Semester: V**	
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 (Audit-Qualifying)	
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
RBL004.1				2	3	3	3	3	3	3	3	3	1	1
RBL004.2				2	3	3	3	3	3	3	3	3	1	1
RBL004.3				2	3	3	3	3	3	3	3	3	1	1
RBL004.4				2	3	3	3	3	3	3	3	3	1	1
RBL004.5				2	3	3	3	3	3	3	3	3	1	1
RBL004.6				2	3	3	3	3	3	3	3	3	1	1
Average				**2.0**	**3.0**	**3.0**	**3.0**	**3.0**	**3.0**	**3.0**	**3.0**	**3.0**	**1.0**	**1.0**

School: SSBSR		**Batch: 2024-28**	
Programme: B.Sc. (Hons.)		**Academic Year: 2026-27**	
Branch: Data Science & Analytics		**Semester: VI**	
1	Course Code	**BDA325**	
2	Course Title	**Deep Learning**	
3	Credits	3	
4	Contact Hours (L-T-P)	3-0-0	
	Course Status	CC	
5	Course Objective	The objective of this course is to provide advance knowledge of Deep learning techniques and also apply Deep learning Techniques to various engineering and social applications.	
6	Course Outcomes	CO1: Ability to identify the deep learning techniques (K2, K3). CO2: Ability to select and implement Machine learning and deep learning (K2,K3,K4) CO3: Ability to Train machine and solve problems associated with batch learning and online learning (K2, K3, K4). CO4: Ability to recognize and implement various ways of selecting suitable model parameters for different machine learning techniques(K3, K4,K5). CO5: Ability to integrate deep learning libraries and mathematical and statistical tools(K4, K5). CO6: Ability to apply Deep learning Techniques to various engineering and social applications(K4, K6).	
7	Course Description	This course mainly focused on Regression and Neural network based Machine learning algorithms. This aim to make students aware of various recent developments in the field of Neural network such as deep learning.	
8			
	Unit 1		
	A	History of Deep Learning, McCulloch Pitts Neuron.	CO1
	B	Multilayer Perceptron's (MLPs), Representation Power of MLPs, Sigmoid Neurons, Gradient Descent.	CO1
	C	Feed Forward Neural Networks, Back propagation.	CO1
	Unit 2		
	A	Gradient Descent (GD), Momentum Based GD, Nesterov Accelerated GD, Stochastic GD.	CO2
	B	Principal Component Analysis and its interpretations, Singular Value Decomposition.	CO2
	C	Auto encoders and relation to PCA, Regularization in auto encoders, Denoising auto encoders, Sparse auto encoders.	CO2
	Unit 3		
	A	Regularization: Bias Variance Tradeoff, L2 regularization, Early stopping, Data set augmentation.	CO3
	B	Greedy Layer wise Pre-training, Better activation functions, Better weight initialization methods, Batch Normalization.	CO3
	C	Learning Vectorial Representations Of Words.	CO3
	Unit 4		
	A	Convolutional Neural Networks, LeNet, AlexNet, ZF-Net, VGGNet, GoogLeNet, ResNet.	CO4

	B	Recurrent Neural Networks, Back propagation through time (BPTT), Vanishing and Exploding Gradients, Truncated BPTT, GRU, LSTMs.	CO4
	C	Encoder Decoder Models, Attention Mechanism, Attention over images.	CO4
	Unit 5		
	A	Advanced Deep architectures: Recurrent Neural networks (RNNs), Generative Adversarial Networks (GANs).	CO5, CO6
	B	In-depth discussion of DL examples.	CO5, CO6
	C	Advanced topics, Recent papers, Influential papers: Visual Question Answering, Visual Dialog, Novel deep methods (Deep internal learning, Deep image prior).	CO5, CO6
	Mode of examination	Practical Based	
	Weightage Distribution	CA:25%; ESE:75%	
	Text book/s*	1. Mahmoud Hassaballah, Ali Ismail Awad: Deep Learning in Computer Vision, Principles and Applications. 2. Dr.P.S. Jagadeesh Kumar, Prof. Thomas Binford, Dr. J. Ruby, J. Lepika. Modern Deep Learning and Advanced Computer Vision, A Perspective Approach.	
	Other References	1. Ian Goodfellow, YoshuaBengio, Aaron Courville, "Deep Learning Adaptive Computation and Machine Learning series", MIT Press. 2. Li Deng and Dong Yu "Deep Learning Methods and Applications", Foundations and Trends in Signal Processing.	

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
BDA325.1		2	1	2		1		3			3	3		
BDA325.2		2	1	2		1		3			3	3		
BDA325.3		2	1	2		1		3			3	3		
BDA325.4		2	1	2		1		3			3	3		
BDA325.5		2	1	2		1		3			3	3		
BDA325.6		2	1	2		1		3			3	3		
Average		**2.0**	**1.0**	**2.0**		**1.0**		**3.0**			**3.0**	**3.0**		

<table>
<tr><td colspan="2">School: SSBSR</td><td>Batch: 2024-28</td></tr>
<tr><td colspan="2">Program: B.Sc. (Research)</td><td>Academic Year: 2026-27</td></tr>
<tr><td colspan="2">Branch: Data Science & Analytics</td><td>Semester: VI</td></tr>
<tr><td>1</td><td>Course Code</td><td>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.
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.</td></tr>
</table>

8	**Theme**	**Major research themes:** 1. ***Survey and self-learning***: In this mode, students will make the survey, analyze data, and will extract results to correlate with their theoretical knowledge. E.g. Crops and animals, land holding, labor problems, medical problems of animals and humans, savage and sanitation situations, waste management, etc. 2. ***Survey and solution providing***: In this mode, students will identify the common problems and will provide solutions/ educate the rural population. E.g. air and water pollution, the need for treatment, use of renewable (mainly solar) energy, electricity-saving devices, inefficiencies in the cropping system, animal husbandry, poultry, pest control, irrigation, machining in agriculture, etc. 3. ***Survey and reporting***: In this mode, students will educate villagers and survey the ground-level status of various government schemes meant for rural development. The analyzed results will be reported to concerned agencies which will help them for taking necessary/corrective measures. E.g. Pradhan Mantri Jan Dhan Yojana, Pradhan Mantri MUDRA Yojana, Pradhan Mantri Jeevan Jyoti Bima Yojana, Atal pension Yojana, Pradhan Mantri Awas Yojana, Pradhan Mantri FasalBima Yojana, Swachh Bharat Abhiyan, Soil Health Card Scheme, Digital India, Skill India Program, BetiBachao, BetiPadhao Yojana, DeenDayal Upadhyaya Gram Jyoti Yojana, Shyama Prasad Mukherjee Rurban Mission, UJWAL Discom Assurance Yojana, PAHAL, Pradhan Mantri Awas Yojana-Gramin, Pradhan Mantri Yuva Yojana, Pradhan Mantri Jan Aushadhi Yojana, Pradhan Mantri KhanijKshetra Kalyan Yojana, Pradhan Mantri Suraksha Bima Yojana, UDAN scheme, DeenDayal Upadhyaya Grameen Kaushalya Yojana, Pradhan Mantri Sukanya Samriddhi Yojana, Sansad Adarsh Gram Yojana, Pradhan Mantri SurakshitMatritva Abhiyan, Pradhan Mantri RojgarProtsahan Yojana, Midday Meal Scheme, Pradhan Mantri Vaya Vandana Yojana, Pradhan Mantri Matritva Vandana Yojana, and Ayushman Bharat Yojana.
9.1	**<u>Guidelines for Faculty Members</u>**	It will be a group assignment. There should be no more than 10 students in each group. The faculty guide will guide the students and approve the project title and help the student in preparing the questionnaire and final report. The questionnaire should be well-designed and it should carry at least 20 questions (Including demographic questions). The faculty will guide the student to prepare the PPT. The topic of the research should be related to social, economical, or environmental issues concerning the common man. The report should contain 2,500 to 3,000 words and relevant charts, tables, and photographs. **A plagiarism check of the report must**. 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	3	2	3	3	3	2	1	2	2	3
CCU108.2	1	2	2	3	3	2	3	3	3	2	1	2	2	3
CCU108.3	1	2	2	3	3	2	3	3	3	2	1	2	2	3
CCU108.4	1	2	2	3	3	2	3	3	3	2	1	2	2	3
CCU108.5	1	2	2	3	3	2	3	3	3	2	1	2	2	3
CCU108.6	1	2	2	3	3	2	3	3	3	2	1	2	2	3
Average	**1.0**	**2.0**	**2.0**	**3.0**	**3.0**	**2.0**	**3.0**	**3.0**	**3.0**	**2.0**	**1.0**	**2.0**	**2.0**	**3.0**

School: SSBSR		**Batch: 2024-28**	
Programme: B.Sc. (Hons.)		**Academic Year: 2026-27**	
Branch: Data Science & Analytics		**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 tosolve specific problems. CO2: Discuss and develop the algorithms to solve system of transcendental 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 divided differences and measure the accuracy. CO5: Discuss and develop the algorithms to solve numerical differentiation and measure the accuracy. CO6: Discuss and develop the algorithms to solve numerical integration and measure the accuracy.	
7	Course Description	This course is an introduction to the numerical analysis. Theprimary 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		
	A, B, C	1. Solution of system of linear equations i) Cramer's rule ii) Gauss elimination and Gauss-Jordan method iii) Jacobi's method, Gauss-Seidal method.	**CO1**
	Unit 2		
	A, B, C	2. System of Transcendental equations i) Bisection method and Method of false position ii)Secant method, iteration method iii) Newton-Raphson method	**CO2**
	Unit 3		
	A, B, C	3. Finite differences and Interpolation i) Newton's forward, backward and divided difference interpolations	**CO3**
	Unit 4		
	A, B, C	4. Divided differences	**CO4**

		i) Newton's divided difference formula ii) Lagrange's interpolation formula.	
	Unit 5		
	A, B, C	5.Numerical differentiation and integration i) Newton's forward and backward formula ii) Trapezoidal rule and Simpson's 1/3 and 3/8 rules.	**CO5,CO6**
	Mode of examination	Practical	
	Weightage Distribution	CA:25%; CE:25%; ESE:50%	
	Text book/s*	1. Gerald Recktenwald: Introduction to Numerical Methods, CRC Press. 2. John H. Mathews, Pearson: Numerical Methods Using MATLAB,	
	Other References	1. César Pérez López: MATLAB Programming for Numerical Analysis, Apress. 2. Steven T., Karris, Numerical Analysis: Using Matlab And Excel, Orchard 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**
CMS371.1	3	3	3	2	2	1	2	3	1	1	3		1	
CMS371.2	3	3	3	2	2	1	2	3	1	1	3		1	
CMS371.3	3	3	3	2	2	1	2	3	1	1	3		1	
CMS371.4	3	3	3	2	2	1	2	3	1	1	3		1	
CMS371.5	3	3	3	2	2	1	2	3	1	1	3		1	
CMS371.6	3	3	3	2	2	1	2	3	1	1	3		1	
Average	**3.0**	**3.0**	**3.0**	**2.0**	**2.0**	**1.0**	**2.0**	**3.0**	**1.0**	**1.0**	**3.0**		**1.0**	

School: SSBSR		**Batch: 2024-28**	
Programme: B.Sc. (Hons.)		**Academic Year: 2026-27**	
Branch: Data Science & Analytics		**Semester: VI**	
1	Course Code	**BDA360**	
2	Course Title	**Statistical Simulation Lab**	
3	Credits	1	
4	Contact Hours (L-T-P)	0-0-2	
	Course Status	CC	
5	Course Objective	The learning objectives include: Concept of simulation and simulation modeling, Generation of Pseudo random number generators as well as from standard statistical distributions, Monte-Carlo simulation technique and application of simulation techniques.	
6	Course Outcomes	CO1: Recognize the concepts of probability and statistics that are relevant to modeling and simulation (K2, K3). CO2: How to generate random numbers by the different methods (K2, K3). CO3: Design and implement Bootstrapping; jackknife resampling (K3, K4). CO4: Be able to evaluate and interpret the Markov-Chain Monte Carlo (MCMC) simulations (K3, K4). CO5: Hands-on experience in using simulation software packages/structured programming languages (K3, K4, K5) CO6: How simulation may be used to understand the behavior of real-world systems by utilizing mathematical models with an emphasis on simulation (K4, K6).	
7	Course Description	The course topics will include a review of concepts from probability and statistics that are relevant to modeling and simulation, algorithms for random-variable sampling, modeling and analysis of basic queueing systems, variance-reduction techniques, statistical-validation techniques, Independent Monte Carlo (IMC) and Markov-Chain Monte Carlo (MCMC) simulations, and discrete-event modeling and simulation.	
8	**Outline syllabus**		**CO Mapping**
	Unit 1	**Lab. Experiment 1**	
	A, B, C	Review of R/Python.	CO1
		Problem Based on Random number generation: Inverse-transform; acceptance-rejection; transformations.	CO1
		Problem Based on Statistic simulations: generating random variables, simulating normal, gamma and beta random variables.	CO1
	Unit 2	**Lab. Experiment 2**	
	A, B, C	Problem Based on Simulating multivariate distributions, MCMC methods.	CO2
		Problem Based on Gibbs sampler, simulating random fields, simulating stochastic process.	CO2
		Problem Based on Variance reduction technique: importance sampling for integration, control variates and antithetic variables.	CO2
	Unit 3	**Lab. Experiment 2**	
	A, B, C	Problem Based on Bootstrapping; jackknife resampling.	CO3
		Problem Based on Bootstrapping for estimation of sampling distribution. Confidence intervals, variance stabilizing transformation.	CO3
		Problem Based on Bootstrapping in regression and sampling from finite populations.	CO3

	Unit 4	**Lab. Experiment 2**	
	A, B, C	Problem Based on Simulating a non-homogeneous Poisson process.	CO4
		Problem Based on Optimization using Monte Carlo methods simulated annealing for optimization.	CO4
		Problem Based on Solving differential equations by Monte Carlo methods.	CO4
	Unit 5	**Lab. Experiment 2**	
	A, B, C	Problem Based on Univariate density estimation; kernel smoothing multivariate density estimation	CO5, CO6
		Problem Based on Root finding; more on numerical integration; numerical maximization/minimization; constrained and unconstrained optimization.	CO5, CO6
		Problem Based on EM (Expectation-Maximization) algorithm; simplex algorithm.	CO5, CO6
	Mode of examination	Practical+Viva	
	Weightage Distribution	CA:25%; CE:25%; ESE:50%	
	Text book/s*	1.Fishman, G.S. Monte Carlo: Concepts, Algorithms and Applications. 2.Rubinstein, R.Y.: Simulation and the Monte Carlo Method.	
	Other References	1. Ross, S. M.: Simulation, Third Edition, Academic Press. 2. Efron, B. and Tibshirani. R.J.: An introduction to the Bootstrap.	

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
BDA360.1	1	2	2	2		1	1	3	1		3	1	2	3
BDA360.2	1	2	3	2		1	1	3	1		3	1	2	3
BDA360.3	1	2	2	2		1	1	3	1		3	1	2	3
BDA360.4	1	2	2	2		1	1	3	1		3	1	2	3
BDA360.5	1	2	2	2		1	1	3	1		3	1	2	3
BDA360.6	1	2	2	2		1	1	3	1		3	1	2	3
Average	**1.0**	**2.0**	**2.0**	**2.0**		**1.0**	**1.0**	**3.0**	**1.0**		**3.0**	**1.0**	**2.0**	**3.0**

School: SSBSR		Batch: 2024-28	
Programme: B.Sc. (Hons.)		Academic Year: 2026-27	
Branch: Data Science & Analytics		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
		Problem based on to check Data Normality	CO1
		Problem based on to check Reliability Testing	CO1
	Unit 2		
	A, B, C	Problem based on Multiple and Partial correlation	CO2
		Problem based on Canonical correlation	CO2
			CO2
	Unit 3		
	A, B, C	Problem based on Principal Component Analysis	CO3
		Problem based on Factor Analysis: Exploratory factor analysis	CO3
		Problem based on Cluster Analysis: Hierarchal Cluster and Non-hierarchal Cluster	CO3
	Unit 4		
	A, B, C	Problem based on Multiple regression analysis	CO4
		Problem based on Logistic regression analysis	CO4
		Problem based on Discriminant Analysis	CO4

	Unit 5		
	A, B, C	Problem based on Analysis of Variance	CO5, CO6
		Problem based on Analysis of and Covariance	CO5, CO6
		Problem based on Multivariate Analysis of Variance and Covariance	CO5, CO6
	Mode of examination	Practical+Viva	
	Weightage Distribution	CA:25%; CE:25%; ESE:50%	
	Text book/s*	1. Johnson, R.A. and Wichern, D.W.: Applied Multivariate Statistical Analysis, Sixth Edition, Pearson Education India. 2. Hardle, W.K. and Hlavka, Z. Multivariate Statistics, Springer.	
	Other References	1. Anderson, T.W.: An Introduction to Multivariate Statistical Analysis, Third Edition, Wiley. 2. Härdle, W.K. and Simar, L. : Applied Multivariate Statistical Analysis, 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	PO 11	PSO 1	PSO 2	PSO 3
BDA361.1	1	2	2	2		1	1	3	1		3	1	2	3
BDA361.2	1	2	3	2		1	1	3	1		3	1	2	3
BDA361.3	1	2	2	2		1	1	3	1		3	1	2	3
BDA361.4	1	2	2	2		1	1	3	1		3	1	2	3
BDA361.5	1	2	2	2		1	1	3	1		3	1	2	3
BDA361.6	1	2	2	2		1	1	3	1		3	1	2	3
Average	**1.0**	**2.0**	**2.0**	**2.0**		**1.0**	**1.0**	**3.0**	**1.0**		**3.0**	**1.0**	**2.0**	**3.0**

Detailed Syllabus for

HONOURS

OR

HONOURS WITH RESEARCH

IN

DATA SCIENCE & ANLYTICS

School: SSBSR		**Batch: 2024-28**	
Programme: B.Sc. (Hons.)		**Academic Year: 2027-28**	
Branch: Data Science & Analytics		**Semester: VII**	
1	Course Code	**MDA104**	
2	Course Title	Next Generation Databases	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
	Course Status	CC	
5	Course Objective	To explore the concepts of NoSQL Databases. To understand and use columnar and distributed database patterns.	
6	Course Outcomes	After completion of this course, students will be able to CO1: Develop and Explore the relationship between Big-Data andNoSQL databases. (K1, K2, K3) CO2: Formulate a fundamental relationship between Big-Data and NoSQL databases. (K2, K3) CO3: Describe various types of NoSQL databases to analyze the big data for useful business applications. (K3, K4) CO4: Derive and Work with NoSQL databases to analyze the big datafor useful business applications. (K4, K5) CO5: Discuss different data models to suit various data representations and storage needs. (K5, K6) CO6: Explain and correlate with different data models to suit variousdata representations and storage needs. (K5, K6)	
7	Course Description	To integrate the intrinsic ideas for the use of various Data models for a variety of databases.	
8	**Outline syllabus**		**CO Mapping**
	Unit 1		
	A	Database Revolutions- system Architecture-RelationalDatabase.	CO1
	B	Database Design-Data Storage-Transaction Management.	CO1
	C	Data warehouse and Data Mining-Information Retrieval.	CO1
	Unit 2		
	A	Big-Data Revolution-CAP Theorem.	CO2
	B	Birth of NoSQL-Document Database—XML Databases.	CO2
	C	JSON Document Databases-Graph Databases.	CO2
	Unit 3		
	A	ColumnDatabases—Data Warehousing Schemes-Columnar Alternative-Sybase IQ-C-Store.	CO3
	B	Vertica-Column Database Architectures-SSD and In-Memory Databases.	CO3
	C	In-Memory Databases-Berkeley Analytics Data Stack andSpark.	CO3
	Unit 4		
	A	Distributed Database Patterns— Distributed Relational Databases-Non- relational Distributed Databases.	CO4
	B	MongoDB – Sharing and Replication-HBase-Cassandra-Consistency Models.	CO4
	C	Types of Consistency-Consistency MongoDB - HBase Consistency-	CO4

		Cassandra Consistency.	
	Unit 5		
	A	Data Models and Storage-SQL-NoSQLAP Is-Return SQL-Advance Databases—Postgre SQL.	CO5, CO6
	B	Riak-CouchDB-NEO4J-Redis-Future, Databases- Revolution Revisited-Counter revolutionaries-Oracle HQ.	CO5, CO6
	C	Other Convergent Databases-Disruptive Database Technologies.	CO5, CO6
	Mode of examination	Theory	
	Weightage Distribution	CA:25%; ESE:75%	
	Text book/s*	1. Abraham Silberschatz, Henry F. Korth, S.Sudarshan, "Database System Concepts", Sixth Edition, McGraw Hill. 2. Guy Harrison, "Next Generation Databases",A Press.	
	Other References	1. Eric Redmond, Jim R Wilson, "Seven Databasesin Seven Weeks", LLC. 2. Dan Sullivan, "NoSQL for Mere Mortals", Addison-Wesley, 2015.	

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
MDA104.1	3	3	2	2		1					3		3	
MDA104.2	2	3	3	2		1					3		3	
MDA104.3	2	2	2	3		1					3		3	
MDA104.4	2	3	2	2		1					3		3	
MDA104.5	3	3	2	2		1					3		3	
MDA104.6	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: 2024-28**	
Programme: B.Sc. (Hons.)		**Academic Year: 2027-28**	
Branch: Data Science & Analytics		**Semester: VII**	
1	Course Code	**MDA109**	
2	Course Title	**Big Data Analytics**	
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 advanced understanding of big data overview, model building, clustering, and advanced analytics.	
6	Course Outcomes	CO1: Discuss the concept of big data analysis and data preparation (K3). CO2: Describe the concept model building, communicate results, and check the basic data analysis. (K1, K2, K3). CO 3: Explain the concept how using R to look at data introduction to R , Analyzing and Exploring the Data, Statistics for Model Building and Evaluation Advanced Analytics. (K3, K4) CO 4: Illustrate the concept of K Means Clustering, association rules, linear regression, logistic regression, and Naïve Bayesian Classifier and evaluate decision trees, time series analysis, and text analysis. (K2, K3, K4). CO 5: Discuss the concept of unstructured data – Map Reduce and Hadoop, The Hadoop Ecosystem In-database Analytics and illustrate SQL Essentials, Advanced SQL, and MADlib for In-database Analytics (K3, K4, K5). CO6: Demonstrate the understanding of the Endgame, or putting it all together: operationalizing an analytics project, creating the final deliverables, data visualization techniques, and final lab exercise on big data analytics (K2, K4, K6).	
7	Course Description	This course is given the deep knowledge of big data, model building, clustering and advance analytics.	
8	**Outline syllabus**		**CO Mapping**
	Unit 1		
	A	State of the Practice in Analytics, the Data Scientist,	CO1
	B	Big Data Analytics in Industry Verticals	CO1
	C	Data Analytics Life cycle: Discovery, Data Preparation, Model Planning.	CO1
	Unit 2	Model Building, Communicating Results, Operationalizing Review of Basic Data Analytic Methods Using R:	CO2
	A	Using R to Look at Data Introduction to R,	CO2
	B	Analyzing and Exploring the Data, Statistics for Model Building, and Evaluation Advanced Analytics.	CO2
	C		
	Unit 3		
	A	K Means Clustering, Association Rules, Linear Regression,	CO3
	B	Logistic Regression, Naïve Bayesian Classifier,	CO3
	C	Decision Trees Time Series Analysis, Text Analysis.	CO3
	Unit 4		
	A	Technologies and Tools: Analytics for Unstructured Data – Map Reduce and Hadoop,	CO4
	B	The Hadoop Ecosystem In-database Analytics – SQL Essentials	CO4
	C	Advanced SQL and MADlib for In-database Analytics	CO4

	Unit 5		
	A	The Endgame, or Putting it All Together: Operationalizing an Analytics Project,	CO5, CO6
	B	Creating the Final Deliverables, Data Visualization Techniques,	CO5, CO6
	C	Final Lab Exercise on Big Data Analytics.	CO5, CO6
	Mode of examination	Theory	
	Weightage Distribution	CA:25%; ESE:75%	
	Text book/s*	1. Tom White, "Hadoop: The Definitive Guide", 3rd edition, O'Reilly Media. 2. Big Data Black Book, Wiley Publications.	
	Other References	1.V. Prajapati, "Big Data Analytics with R and Hadoop", Packt Pub. 2.N. Dasgupta, Practical Big Data Analytics, Packt Publication 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**
MDA109.1	3	3	2	2		1					3		3	
MDA109.2	2	3	3	2		1					3		3	
MDA109.3	2	2	2	3		1					3		3	
MDA109.4	2	3	2	2		1					3		3	
MDA109.5	3	3	2	2		1					3		3	
MDA109.6	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: 2024-28**	
Programme: B.Sc. (Hons.)		**Academic Year: 2027-28**	
Branch: Data Science & Analytics		**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. Gupta, S.C. and Kapoor, V.K., "Fundamental of Mathematical Statistics".	
	Other References	1. Grewal, B.S, "Higher Engineering Mathematics". 2. 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: 2024-28**	
Programme: B.Sc. (Hons.)		**Academic Year: 2027-28**	
Branch: Data Science & Analytics		**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.: Nonparametric Statistical Inference, 5th Edition. CRC Press. 2. Hollander, M., Wolfe, D. & Chicken, E.. Nonparametric Statistical Methods, 3rd Edition. Wiley.	
	Other References	1. Bonnini, S., Corain, L., Marozzi, M. & Salmaso, L.: Nonparametric Hypothesis Testing Rank and Permutation Methods with Applications in R. Wiley. 2. Sprent, P. & Smeeton, N.C. (2013): Applied Nonparametric Statistical Methods, 4th Edition. CRC Press.	

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	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: 2024-28**	
Programme: B.Sc. (Hons.)		**Academic Year: 2027-28**	
Branch: Data Science & Analytics		**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.Gujrati, D.N. & Porter, D.C.: Basic Econometrics, 6th Edition. McGraw Hill. 2. Maddala, G.S. & Lahiri, K.: Introduction to Econometrics, 4th Edition. Wiley.	
	Other References	1. Greene, W.H.: Econometric Analysis, 7th Edition. Pearson. 2. Studenmund, A.H. &Johnson, B.K.: Using Econometrics: A Practical Guide, 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	1	2		1		3			3	1	1	1
MDA112.2		2	1	2		1		3			3	1	1	1
MDA112.3		2	1	2		1		3			3	1	1	1
MDA112.4		2	1	2		1		3			3	1	1	1
MDA112.5		2	1	2		1		3			3	1	1	1
MDA112.6		2	1	2		1		3			3	1	1	1
Average		**2.0**	**1.0**	**2.0**		**1.0**		**3.0**			**3.0**	**1.0**	**1.0**	**1.0**

School: SSBSR		**Batch: 2024-28**	
Programme: B.Sc. (Hons.)		**Academic Year: 2027-28**	
Branch: Data Science & Analytics		**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 hazard functions.	CO3
	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.: Statistical Methods for Survival Data Analysis, 3rdEdition. John Wiley. 2. Liu, X: Survival Analysis: Models and Applications, Wiley, New York.	
	Other References	1. Kleinbaum, D. G. and Klein, M.: Survival Analysis: A Self-Learning Text, 3rdEd, Springer, New York. 2. Hosmer, D. and Lemeshow, S.: Applied Survival Analysis: Regression Modeling of Time to Event Data, 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		2	1	2		1		3			3		1	1
MDA113.2		2	1	2		1		3			3		1	1
MDA113.3		2	1	2		1		3			3		1	1
MDA113.4		2	1	2		1		3			3		1	1
MDA113.5		2	1	2		1		3			3		1	1
MDA113.6		2	1	2		1		3			3		1	1
Average		**2.0**	**1.0**	**2.0**		**1.0**		**3.0**			**3.0**		**1.0**	**1.0**

School: SSBSR		Batch: 2024-28	
Programme: B.Sc. (Hons.)		Academic Year: 2027-28	
Branch: Data Science & Analytics		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 data's trend by the method of the freehand curve, Moving average curve, semi-average	CO2

		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. 2. Fuller, W. A. (2009). Introduction to statistical time series. John Wiley & Sons.	
	Other References	1. Dan L. Shunk: Time Series Modeling for Analysis and Control: Advanced Autoregressive Techniques"	

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

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

School: SSBSR		Batch: 2024-28	
Programme: B.Sc. (Hons.)		Academic Year: 2027-28	
Branch: Data Science & Analytics		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.Gujrati, D.N. & Porter, D.C.: Basic Econometrics, 6th Edition. McGraw Hill. 2. Maddala, G.S. & Lahiri, K.: Introduction to Econometrics, 4th Edition. Wiley.	
	Other References	1. Greene, W.H.: Econometric Analysis, 7th Edition. Pearson. 2. Studenmund, A.H. &Johnson, B.K.: Using Econometrics: A Practical Guide, 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**
MDA156.1	1	2	2	2		1	1	3	1		3	1	2	3
MDA156.2	1	2	3	2		1	1	3	1		3	1	2	3
MDA156.3	1	2	2	2		1	1	3	1		3	1	2	3
MDA156.4	1	2	2	2		1	1	3	1		3	1	2	3
MDA156.5	1	2	2	2		1	1	3	1		3	1	2	3
MDA156.6	1	2	2	2		1	1	3	1		3	1	2	3
Average	**1.0**	**2.0**	**2.0**	**2.0**		**1.0**	**1.0**	**3.0**	**1.0**		**3.0**	**1.0**	**2.0**	**3.0**

School: SSBSR		**Batch: 2024-28**	
Programme: B.Sc. (Hons.)		**Academic Year: 2027-28**	
Branch: Data Science & Analytics		**Semester: VIII**	
1	Course Code	**MDA107**	
2	Course Title	**Advanced Big Data and Text Analytics**	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
	Course Status	CC	
5	Course Objective	This course aims to provide insight into the concepts of Natural Language Processing and its applications. This course helps the students to implement NLP applications using deep learning algorithms. This course helps to understand various word/text representation algorithms.	
6	Course Outcomes	At the end of the course, the student should be able to CO1: Learn about Big data techniques and their applications. CO2: Analyse various neural network problems. CO3: Use different word/text representation methods to see how words are related to each other. CO4: Model different NLP applications using Machine Learning/Deep learning algorithms CO5: Implement different deep learning models to solve real-time NLP problems CO6: Provide a body of concepts and techniques for designing intelligent systems.	
7	Course Description	A UG-level course in Soft Computing Techniques to Improve Big Data Analysis solutions is to strengthen the dialogue between the statistics and soft computing research communities.	
8	**Outline syllabus**		**CO Mapping**
	Unit 1		
	A	Introduction to Big Data: Introduction to Big Data, Big Data characteristics	CO1
	B	Types of Big Data, Structured Data, Unstructured Data, and semi Structured Data.	CO1
	C	Traditional vs. Big Data business approach, Case Study of Big Data Solutions.	CO1
	Unit 2		
	A	Mining Data Streams: The Stream Data Model: A Data Stream-Management System, Examples of Stream Sources, Stream Queries, Issues in Stream Processing.	CO2
	B	Sampling Data in a Stream: Obtaining a Representative Sample, The General Sampling Problem, Varying the Sample Size. Filtering Streams: The Bloom Filter, Analysis.	CO2
	C	Counting Distinct Elements in a Stream The Count-Distinct Problem, The Flajolet-Martin Algorithm, Combining Estimates, Space Requirements Counting Ones in a Window: The Cost of Exact Counts.	CO2
	Unit 3		
	A	The Big Data Analytics and Big Data Analytics Techniques: Big Data and its Importance, Drivers for Big data, Optimization techniques, Dimensionality Reduction techniques.	CO3
	B	Time series Forecasting, Social Media Mining, and Social Network Analysis, and its Application.	CO3

	C	Big Data analysis using Hadoop, Pig, Hive, MongoDB, Spark, and Mahout, Data analysis techniques.	CO3
	Unit 4		
	A	Introduction to Natural Language Processing Words Regular Expressions N-grams Language modeling Part of Speech.	CO4
	B	Tagging Named Entity Recognition Syntactic and Semantic Parsing-Morphological Analysis	CO4
	C	Text Representation and Transformation-Vector space models Bag of Words Term Frequency Inverse Document Frequency Word Vector representations: Word2vec, GloVe, FastText, BERT-Topic Modelling	CO4
	Unit 5		
	A	Neural language models - Recurrent Neural Network - Long Short-Term Memory Networks	CO5
	B	Encoder decoder architecture - Attention Mechanism - Transformer networks	CO6
	C	Text classification-Sentiment Analysis-Neural Machine Translation - Question answering - Text summarization	CO6
	Mode of examination	Theory	
	Weightage Distribution	CA:25%; ESE:75%	
	Text book/s*	1. S.N. Sivanandam& S.N. Deepa, Principles of Soft Computing, Wiley Publications, 2nd Edition. 2.S, Rajasekaran& G.A. VijayalakshmiPai, Neural Networks,	
	Other References	1.N. K. Bose, Ping Liang, Neural Network fundamental with Graph, Algorithms & Applications, TMH, 1st Edition. 2. Martin T Hagen, Neural Network Design, Nelson Candad, 2nd 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
MDA107.1	3	3	2	2		1					3			
MDA107.2	2	3	3	2		1					3			
MDA107.3	2	2	2	3		1					3			
MDA107.4	2	3	2	2		1					3			
MDA107.5	3	3	2	2		1					3			
MDA107.6	3	3	2	3		1					3			
Average	**2.3**	**2.6**	**2.0**	**2.1**		**1.0**					**3.0**			

School: SSBSR		Batch: 2024-28	
Programme: B.Sc. (Hons.)		Academic Year: 2027-28	
Branch: Data Science & Analytics		Semester: VIII	
1	Course Code	MDA114	
2	Course Title	Bayesian Data 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 concepts of preparing your data; Working with dates and times, Data Cleaning, Data Structure, and cleaning Text Data.	
6	Course Outcomes	CO1: Explain in detail the Bayesian framework for data analysis and its flexibility and be able to demonstrate when the Bayesian approach can be beneficial. CO2: Develop, analytically describe, and implement both single and Multi-Parameter probability models in the Bayesian framework. CO3: Demonstrate the role of the prior distribution in Bayesian inference and be able to articulate the usage of non-informative priors and conjugate priors. CO4: Show high level Interpretation of Bayesian Analysis Results and be able to readily perform Bayesian model evaluation and assessment. CO5: Demonstrate the necessary skills to: fit hierarchical models, provide thorough technical specifications for these models. CO6: Bayesian statistical practice makes extensive use of versions of objective b.ayesian analysis	
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		
	A	Limitations of empirical and logical theories of probability	CO1
	B	Subjective probability, determination of subjective probability, likelihood function, prior distribution, posterior distribution	CO1
	C	Bayes' theorem, methods of construction of priors and computation of the posterior distribution.	CO1
	Unit 2		
	A	Natural conjugate family of priors for a model.	CO2
	B	Hyper parameters of a prior from conjugate family.	CO2
	C	Conjugate families for (i) exponential family models, (ii) models admitting sufficient statistics of fixed dimension.	CO2
	Unit 3		

	A	Enlarging the natural conjugate family by (i) enlarging hyper parameter space (ii) mixtures from conjugate family	CO3
	B	Choosing an appropriate member of conjugate prior family.	CO3
	C	Non-informative, improper and invariant priors. Jeffrey's invariant prior.	CO3C
	Unit 4		
	A	Bayesian point estimation: As a prediction problem from posterior distribution.	CO4
	B	Bayes estimators for (i) absolute error loss (ii) squared error loss (iii) 0-1 loss function.	CO4
	C	Generalization to convex loss functions. Evaluation of the estimate in terms of the posterior risk.	CO4
	Unit 5		
	A	Bayesian interval estimation: Credible intervals.	CO5
	B	Highest posterior density regions. Interpretation of the confidence coefficient of an interval and its comparison with the interpretation of the confidence coefficient for a classical confidence interval.	CO5
	C	Bayesian testing of hypothesis: Specification of appropriate form of the prior distribution for a Bayesian testing of hypothesis problem.	CO6
	Mode of examination	Theory	
	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 2. Best Practices in Data Cleaning: A Complete Guide to Everything You Need to Do Before and After Collecting Your Data by Jason W Osborne	
	Other References	1. Data Wrangling with Python by Jacqueline Kazil 2. Principles of Data Wrangling: Practical Techniques for Data Preparation by Tye Rattenbury	

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
MDA114.1		2	1	2		1		3			3		1	1
MDA114.2		2	1	2		1		3			3		1	1
MDA114.3		2	1	2		1		3			3		1	1
MDA114.4		2	1	2		1		3			3		1	1
MDA114.5		2	1	2		1		3			3		1	1
MDA114.6		2	1	2		1		3			3		1	1
Average		**2.0**	**1.0**	**2.0**		**1.0**		**3.0**			**3.0**		**1.0**	**1.0**

School: SSBSR		**Batch: 2024-28**	
Programme: B.Sc. (Hons.)		**Academic Year: 2027-28**	
Branch: Data Science & Analytics		**Semester: VIII**	
1	Course Code	**MDA117**	
2	Course Title	**Computational Intelligence**	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
	Course Status	CC	
5	Course Objective	To provide a strong foundation on fundamental concepts in Computational Intelligence. To enable Problem-solving through various searching techniques.	
6	Course Outcomes	CO1: Provide a basic exposition to the goals and methods of Computational Intelligence. CO2: Study of the design of intelligent computational techniques. CO3: Apply the Intelligent techniques for problem solving CO4: Improve problem solving skills using the acquired knowledge in the areas of reasoning, natural language understanding, computer vision, automatic programming and machine learning. CO5: Learn about the advance concept of AI CO6: Explain computable functions, predicates, forward and backward reasoning	
7	Course Description	To apply these techniques in applications which involve perception, reasoning and learning. To apply Computational Intelligence techniques for information retrieval. To apply Computational Intelligence techniques primarily for machine learning.	
8	**Outline syllabus**		**CO Mapping**
	Unit 1		
	A	Introduction to Artificial Intelligence-Search-Heuristic	CO1,
	B	Search A* algorithm Game Playing Alpha Beta Pruning Expert systems	CO1,
	C	Inference Rules Forward Chaining and Backward Chaining Genetic Algorithms	CO1,
	Unit 2		
	A	Proposition Logic First Order Predicate Logic Unification Forward Chaining	CO2
	B	Backward Chaining Resolution Knowledge Representation Ontological Engineering Categories and Objects	CO2
	C	Event Mental Events and Mental Objects Reasoning Systems for Categories Reasoning with Default Information Prolog Programming.	CO3
	Unit 3		
	A	Non-monotonic reasoning-Fuzzy	CO4
	B	Logic Fuzzy rules fuzzy inference Temporal Logic	CO4
	C	Temporal Reasoning Neural Networks Neuro Fuzzy Inference.	CO4

	Unit 4		
	A	Probability basics - Bayes Rule and its Applications Bayesian Networks Exact and Approximate Inference in Bayesian Networks Hidden Markov Models Forms of Learning	CO5
	B	Supervised Learning - Learning Decision Trees – Regression and Classification with Linear Models - Artificial Neural Networks –	CO5
	C	Nonparametric Models Support Vector Machines Statistical Learning, Learning with Complete Data Learning with Hidden Variables- The EM Algorithm Reinforcement Learning.	CO5
	Unit 5		
	A	Natural language processing-Morphological Analysis Syntax analysis	CO6
	B	Semantic Analysis All applications Language Models Information Retrieval Information	CO6
	C	Extraction Machine Translation Machine Learning Symbol Based Machine Learning: Connectionist Machine Learning.	CO6
	Mode of examination	Theory	
	Weightage Distribution	CA:25%; ESE:75%	
	Text book/s*	1. Stuart Russell, Peter Norvig, Artificial Intelligence: A Modern Approach‖, Third Edition, Pearson Education / Prentice Hall of India. 2. Elaine Rich and Kevin Knight, Artificial Intelligence‖, Third Edition, Tata McGraw- Hill.	
	Other References	1. Patrick H. Winston. "Artificial Intelligence", Third edition, Pearson Edition. 2. Dan W. Patterson, Introduction to Artificial Intelligence and Expert Systems‖, PHI.	

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MDA117.2		2	1	2		1		3			3		1	1
MDA117.3		2	1	2		1		3			3		1	1
MDA117.4		2	1	2		1		3			3		1	1
MDA117.5		2	1	2		1		3			3		1	1
MDA117.6		2	1	2		1		3			3		1	1
Average		**2.0**	**1.0**	**2.0**		**1.0**		**3.0**			**3.0**		**1.0**	**1.0**

School: SSBSR		**Batch: 2024-28**	
Programme: B.Sc. (Hons.)		**Academic Year: 2027-28**	
Branch: Data Science & Analytics		**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. CO6: Identify appropriate sources of data, perform basic demographic analyses using various techniques and ensure their comparability across populations.	
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. Agarwal S.S.: India's Population Problem- Tata McGraw Hill Publication, Bombay 2. Bhende A.A. and Tara Kanitkar: 'Principles of Population Studies'- Himalaya Publishing House, Bombay	
	Other References	1. Hans Raj: 'Fundamentals of Demography'-Surjeet Publication, Delhi 2. Srinivasan K.: 'Basic Demographic Techniques and Applications', Sage Publications, New Delhi.	

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MDA115.2		2	1	2		1		3			3	3	3	
MDA115.3		2	1	2		1		3			3	3	3	
MDA115.4		2	1	2		1		3			3	3	3	
MDA115.5		2	1	2		1		3			3	3	3	
MDA115.6		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**	

School: SSBSR		**Batch: 2024-28**	
Programme: B.Sc. (Hons.)		**Academic Year: 2027-28**	
Branch: Data Science & Analytics		**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. 2. M. Jeya Chandra, Statistical Quality Control, CRC Press.	
	Other References	1.Eugene Lodewick Grant, Richard S. Leavenworth, Statistical Quality Control, McGraw-Hill.	

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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**	