Bachelor of Sciences (H)
Data Science

Program and Course Structure

School of Basic Science and Research

Department of Mathematics

B.Sc. (H) (Data Science)

SBR0308

Batch 2020-23

1.1 Vision, Mission and Core Values of the University

Vision of the University

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

Mission of the University

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

Core Values

- **Integrity**
- **Leadership**
- **Diversity**
- **Community**

1.2 Vision and Mission of the 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

- **Integrity**
- **Leadership**
- **Diversity**
- **Community**

1.3 Vision and Mission 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 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

- **Integrity**
- **Leadership**
- **Diversity**
- **Community**

B. Sc. (H) Data Science

1.4 Programme Educational Objectives (PEO's)

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.

1.4.1Program Outcomes (PO's)

PO1: Data Science knowledge: Application of Data Science knowledge in various fields of science, engineering and management etc.

PO2: Nature of Data Science: Understand the concise, precise and rigorous nature of Data Science.

PO3: `Critical thinking: Develop the skill to think critically on abstract concepts of Data Science.

PO4: Problem analysis: Develop the ability to analyze a problem logically and dissect into micro-parts and thus resolving the problem to accessible components.

PO5: Presentation skill: Develop the skill to pleasant exposition for successful presentation for any career interview with confidence.

PO6: Data Science logic: Formulates and develops data analysis arguments in logical manner.

PO7: Team Work: Work as a team player and strive for self-excellence.

PO8: **Ethics:** Realize and understand professional, ethical and cultural responsibilities.

PO9: Communication: Communicate effectively with an elite audience.

PO10:Life-long learning: Engage in life-long learning towards enduring professional development.

1.4.2 Mapping of PEOs with Mission Statements:

PEO Statements	School Mission 1	School Mission 2	School Mission 3	School Mission 4	School Mission 5	School Mission 6
PEO1:	3	2	3	1	2	3
PEO2:	3	2	3	1	2	3
PEO3:	3	3	3	3	3	3
PEO4:	3	2	3	1	3	3
PEO5:	3	2	2	2	3	3

1.4.3 Mapping of Program Outcome Vs Program Educational Objectivess

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

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

1.4.5 Program Outcome Vs Courses Mapping Table:

1.4.5.1 COURSE ARTICULATION MATRIX

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
MSM 101	1	2	1	2	2	1	2	1	1	2
MSM 312	1	2	2	1	2	1	2	1	1	1
BDA 101	2	1	1	2	1	2	2	1	2	2
EVS106	1	1	2	1	1	1	1	2	1	2
ARP 101	2	1	1	1	2	2	1	2	2	1
BDA 103	1	1	1	1	2	1	1	2	2	1
BDA104	3	3	2	3	2	2	1	2	2	1
MSM106	1	2	1	2	2	1	2	1	1	2
BDA105	2	2	1	2	2	1	2	1	1	2
BDA106	1	2	1	2	2	1	2	1	1	2
BDA107	3	3	2	3	3	2	2	1	2	2
BDA108	2	3	3	3	2	2	2	1	2	2
BDA110	1	2	1	2	2	1	2	1	1	2
BDA 111	1	1	1	1	2	1	1	2	2	1

MSM 213	2	1	1	2	2	1	1	2	2	1
BDA 201	3	3	2	2	3	2	2	2	2	2
BDA202	3	3	2	3	2	2	2	2	1	2
BDA205	2	3	2	3	2	2	3	2	2	2
BDA 204	2	1	2	1	2	1	1	2	2	1
BDA 211	2	1	1	1	2	1	1	2	2	1
CCU 401	-	-	1	1	2	-	2	1	-	2
BDA203	3	3	2	3	2	3	2	3	2	2
BDA206	3	3	2	3	2	3	2	3	2	2
BDA207	2	3	2	3	2	3	2	2	2	2
BDA208	2	3	2	3	2	2	3	2	2	2
BDA209	3	3	3	3	2	2	2	2	3	2
BDA210	2	3	2	3	3	2	2	2	2	1
BDA301	3	3	2	3	2	2	2	2	1	2
BDA302	2	3	2	3	2	2	3	2	2	2
BDA303	3	3	2	3	3	2	3	2	2	3
BDA 304	3	3	2	3	3	2	2	2	2	2
MSM315	3	3	3	3	2	2	2	2	2	3
XXXX										
BDA305	3	3	2	2	3	2	2	2	2	2

BDA306	3	3	2	3	3	2	2	2	2	2
XXX										
XXX										
BDA307	3	3	3	3	2	2	2	2	2	1
BDA308	2	3	2	2	3	2	2	2	2	2

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

Program Structure Template
Department of Mathematics
School of Basic Sciences & Research
B. Sc. (H) Data Science
Batch: 2020-2023
TERM: I

S. No.	SUBJECT CODE	Title of Paper	Teaching Load				CREDITS	PRE-REQUISITE/ CO-REQUISITE	Type of Course[1]: 1. CC 2. AECC 3. SEC 4. DSE
	THEORY								
			L	**T**	**P**	**TOTAL**			
1.	MSM 101	Foundation course in Mathematics	3	1	0	4	4	Pre-Requisite	
2.	MSM 312	Discrete Mathematics	3	1	0	4	4	Co Requisite	
3.	BDA 101	Statistics I	3	0	1	5	4	Co Requisite	
4.	EVS106	Environmental Science	3	0	0	3	3	Co Requisite	
5.	ARP 101	Communicative English I	1	0	1	3	2	Co Requisite	**AECC**
6.	BDA 103	Fundamentals of Computers & Problem solving using C	2	0	1	4	3	Co Requisite	SEC
7.	BDA104	Programming R	2	0	1	4	3	Co Requisite	**AECC**
TOTAL			**17**	**2**	**4**	**27**	**23**		

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

Program Structure Template
Department of Mathematics
School of Basic Sciences & Research
B. Sc. (H) Data Science
Batch: 2020-2023
TERM: II

S. No.	SUBJECT CODE	Title of Paper	Teaching Load				CREDITS	PRE-REQUISITE/ CO-REQUISITE	Type of Course2: 1. CC 2. AECC 3. SEC 4. DSE
	THEORY								
			L	**T**	**P**	**TOTAL**			
1	MSM106	Linear Algebra	3	1	0	4	4	Co Requisite	
2	BDA105	Statistics II	3	0	0	3	3	Co Requisite	
3	BDA106	Statistics III	3	0	1	5	4	Co Requisite	
4	BDA107	Differential Equations & Complex Variable	3	1	0	4	4	Co Requisite	
5	BDA108	Introduction to Computer organization	3	0	0	3	3	Co Requisite	
6	BDA110	Data Structure & Algorithms	3	0	1	5	4	Co Requisite	DSE
7	BDA 111	Introduction to MATLAB in Data Analysis	2	0	2	5	4	Co Requisite	AECC
TOTAL			**20**	**2**	**4**	**29**	**26**		

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

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Department of Mathematics
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Batch: 2020-2023
TERM: III

S. No.	SUBJECT CODE	Title of Paper	Teaching Load				CREDITS	PRE-REQUISITE/ CO-REQUISITE	Type of Course3: 1. CC 2. AECC 3. SEC 4. DSE
	THEORY								
			L	**T**	**P**	**TOTAL**			
1.	MSM 213	Numerical Analysis	3	0	1	5	4		CC
2.	BDA 201	Data preparation and Data Cleaning	3	0	1	5	4		CC
3.	BDA202	Database Management Systems	3	0	1	5	4		AECC
4.	BDA205	Data Ware housing and Data mining	3	0	1	5	4	Co-requisite	
5.	BDA 204	Operating Systems	3	0	1	5	4	Co-requisite	
6.	BDA 211	Oops using Python	2	0	1	4	3		
7.	CCU 401	Community Connect	0	0	2	2	2		
TOTAL			**17**	**0**	**8**	**31**	**25**		

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

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TERM: IV

S. No.	SUBJECT CODE	Title of Paper	Teaching Load				CREDITS	PRE-REQUISITE/ CO-REQUISITE	Type of Course4: 1. CC 2. AECC 3. SEC 4. DSE
	THEORY								
			L	**T**	**P**	**TOTAL**			
1.	BDA203	Text Analytics	3	0	1	5	4		CC
2.	BDA206	Regression, time series, forecasting and Index numbers	3	0	1	5	4		CC
3.	BDA207	Multivariate Analysis	3	0	1	5	4		CC
4.	BDA208	Statistical Inference (non- parametric)	3	0	1	5	4		CC
5.	BDA209	Recommender Systems	3	0	1	5	4		CC
6.	BDA210	Data Visualization	3	0	1	5	4		AECC
TOTAL			**18**	**0**	**6**	**30**	**24**		

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

Program Structure Template
Department of Mathematics
School of Basic Sciences & Research
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TERM: V

S. No.	SUBJECT CODE	Title of Paper	Teaching Load				CREDITS	PRE-REQUISITE/ CO-REQUISITE	Type of Course5: 1. CC 2. AECC 3. SEC 4. DSE
	THEORY								
			L	**T**	**P**	**TOTAL**			
1.	BDA301	Statistical Analysis (Count Data and survival Analysis)	3	0	1	5	4		CC
2.	BDA302	Data Scientist Toolbox	3	0	1	5	4		CC
3.	BDA303	Machine learning	3	0	1	5	4		CC
4.	BDA 304	Statistical Simulation	3	0	1	5	4		CC
5.	MSM315	Operational Research	3	1	0	4	4		CC
6.	XXXX	Elective-I	3	0	1	5	4		AECC
TOTAL			**18**	**1**	**5**	**29**	**24**		

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

Program Structure Template
Department of Mathematics
School of Basic Sciences & Research
B. Sc. (H) Data Science
Batch: 2020-2023

TERM: VI

S. No.	SUBJECT CODE	Title of Paper	Teaching Load				CREDITS	PRE-REQUISITE/ CO-REQUISITE	Type of Course6: 1. CC 2. AECC 3. SEC 4. DSE
	THEORY								
			L	**T**	**P**	**TOTAL**			
1.	BDA305	Deep Learning	3	0	1	5	4		CC
2.	BDA306	Big Data Analytics	3	0	1	5	4		CC
3.	XXX	Elective-II	3	0	1	5	4		CC
4.	XXX	Elective-III	3	0	1	5	4		CC
5.	BDA307	Capstone project	6	0	0	6	6		CC
6.	BDA308	Research report writing and Presentation	0	0	2	3	2		
TOTAL			**18**	**0**	**6**	**29**	**24**		

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

Foundation Course in Mathematics (MSM 101)

School: SBSR		**Batch : 2020- 2023**	
Program: B.Sc. (H)		**Current Academic Year: 2020-21**	
Branch: Data Science		**Semester: I**	
1	Course Code	MSM 101	
2	Course Title	FOUNDATION COUSE IN MATHEMATICS	
3	Credits	4	
4	Contact Hours (L-T-P)	3-1-0	
	Course Status	Compulsory	
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,K 3,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 Foundation course in Mathematics**		**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	CO1

		symmetric matrix. Inverse of matrix.			
	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	**Sets Theory**			
	A	Definition of set, types of sets, Union and intersection of sets, Venn diagram, De-Morgan's law.			CO5
	B	Relation and functions.			CO5
	C	Composite function and inverse function.			CO5
	Unit 5	**Vector Algebra**			
	A	Addition and subtraction of vectors and their geometric application.			CO6
	B	Scalar and vector product, their physical application, Projection of vector on another vector, area of triangle.			CO6
	C	Area of parallelogram and quadrilateral, Vector triple product.			CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Text book/s*	1. Kreyszig, E., "Advanced Engineering Mathematics", John Wiley & Sons Inc. 1. 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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
C101.1	3	3	2	2	2	3	2	2	1	1
C101.2	2	3	3	2	2	2	1	2	1	1
C101.3	2	2	2	3	3	2	1	1	2	2
C101.4	2	3	2	2	2	2	1	2	2	2
C101.5	3	3	2	2	2	1	2	1	2	1
C101.6	3	3	2	3	2	2	1	2	2	1

Communicative English-1 (ARP 101)

School: SBSR		Batch : 2020- 2023
Program: B.Sc. (H)		Current Academic Year: 2020-21
Branch: Data Science		Semester: I
1	Course Code	ARP101
2	Course Title	Communicative English-1
3	Credits	3
4	Contact Hours (L-T-P)	1-0-1
	Course Status	Compulsory
5	Course Objective	To minimize the linguistic barriers that emerge invaried socio-linguistic environments through the use of English. Help students to understand different accents and standardise their existing English. Guide the students to hone the basic communication skills - listening, speaking, reading and writing while also uplifting their perception of themselves, giving them self-confidence and building positive attitude.
6	Course Outcomes	CO1 Learn to use correct sentence structure and punctuation as well as different parts of speech. CO2 Learning new words its application and usage in different contexts helpful in building meaning conversations and written drafts. Develop over all comprehension ability, interpret it and describe it in writing. Very useful in real life situations and scenarios. CO2 A recognition of one's self and abilities through language learning and personality development training leading up to greater employability chances. Learn to express oneself through writing while also developing positive perception of self. To be able to speak confidently in English CO3 To empower them to capitalise on strengths, overcome weaknesses, exploit opportunities, and counter threats. To ingrain the spirit of Positive attitude in students through a full length feature film followed by a storyboarding activity. Create a Self Brand, identity and self esteem through various interesting and engaging classroom activity CO4 Exposing students to simulations and situations wherein students learn to describe people and situations and handle such situations effectively and with ease. Teaching students how to engage in meaningful dialogues and active conversational abilities to navigate through challenging situations in life and make effective conversations. CO5 Learn how to transform adverse beginnings into positive endings – through writing activities like story completion.
7	Course Description	The course is designed to equip students, who are at a very basic level of language comprehension, to communicate and work with ease in varied workplace environment. The course begins with basic grammar structure

		and pronunciation patterns, leading up to apprehension of oneself through written and verbal expression as a first step towards greater employability.			
8	**Outline syllabus**				**CO Mapping**
	Unit 1	Sentence Structure			
	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			CO2
	B	Punctuation/ Spellings (Prefixes-suffixes/Unjumbled Words)			CO2
	C	Conjunctions/Compound Sentences			CO2
	Unit 3	Writing Skills			
	A	Picture Description – Student Group Activity			CO3
	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)			CO3,CO4
	Unit 4	Speaking Skill			
	A	Self-introduction/Greeting/Meeting people – Self branding			CO4, CO5
	B	Describing people and situations - To Sir With Love (Watching a Full length Feature Film)			CO4, CO5
	C	Dialogues/conversations (Situation based Role Plays)			CO4
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		60%		40%	
	Text book/s*	• Blum, M. Rosen. How to Build Better Vocabulary. London: Bloomsbury Publication • Comfort, Jeremy(et.al). Speaking Effectively. Cambridge University Press			
	Other References				

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
C101.1	-	-	-	-	1	-	1	1	1	1
C101.2	-	-	-	-	-	-	1	1	1	2
C101.3	-	-	-	-	1	-	1	1	1	2
C101.4	-	-	-	-	1	-	1	1	1	2
C101.5	-	-	-	-	-	-	1	1	1	1

Fundamentals of Computers & Problem Solving using C BDA 103

School: SBSR		Batch : 2020-2023	
Program: B.Sc.(H)		Current Academic Year:2020-21	
Branch: Data Science		Semester: I	
1	Course Code	BDA103	Course Name:
2	Course Title	Fundamentals of Computers & Problem Solving using C	
3	Credits	4	
4	Contact Hours (L-T-P)	3-0-1	
	Course Status		
5	Course Objective	To understand and demonstrate how to solve logical and scientific problems using programming.	
6	Course Outcomes	CO1: Explain the concept of key components of a computer system. (K2,K3, K4) CO2: Apply and practice logical ability to solve the problems. (K2, K3, K4) CO3: Describe how to generate efficient and schematic solution to the problems. (K1, K2)	
7	Course Description	To understand and demonstrate how to solve logical and scientific problems using programming.	
8	Outline syllabus		CO Mapping
	Unit 1	Basics of computers	
	A	Introduction to Programming; Introduction to components of a computer system: disks, memory,	CO1, CO2
	B	processor, where a program is stored	CO1, CO2
	C	Executed, operating system, compilers etc.	CO1, CO2
	Unit 2	Fundamental of Logic Buildings (Algorithms)	
	A	Idea of Algorithm: steps to solve logical and numerical problems.	CO1, CO2,CO3
	B	Representation of Algorithm: Flowchart/Pseudo code with examples; From algorithms to programs;	CO1, CO2,CO3
	C	source code, variables (with data types) variables and memory; locations, Syntax and Logical Errors in compilation, object and executable code.	CO1, CO2,CO3

	Unit 3	Basics of Flowcharts			
	A	Flowchart: Elements, need of input and output.			CO2,CO3
	B	Identifying and understanding input/output, branching and iterations in flowchart.			CO2,CO3
	C	Conversion of algorithms in flowchart.			CO2,CO3
	Unit 4	C Language-I			
	A	Introduction to C programming language: Structure of a C program.			CO3
	B	Compilation and execution of C program. Data types, Variables, Constants, Identifiers and keywords, Operators.			CO2,CO3
	C	Types of Statements: Assignment, Control, jumping.			CO2,CO3
	Unit 5	C Language-II			
	A	Control statements: Decisions, Loops, break, continue			CO2,CO3
	B	Nesded Loop			CO2,CO3
	C	Arrays: One dimensional Array, Sorting, Searching			CO2,CO3
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	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

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
C103.1	**2**	**2**	**2**	**2**	**1**	**2**	**1**	**2**	**1**	**2**
C103.2	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**2**
C103.3	**1**	**2**	**1**	**1**	**2**	**2**	**2**	**1**	**2**	**1**

Environmental Science (EVS 106)

School:		**Batch : 2020-2023**	
Program:		**Current Academic Year: 2020-2021**	
Branch: Data Science		**Semester: I**	
1	Course Code	**EVS-106**	
2	Course Title	Environmental Science	
3	Credits	03	
4	Contact Hours (L-T-P)	3-0-0	
	Course Status	Compulsory	
5	Course Objective	1. Enable students to learn the concepts, principles and importance of environmental science 2. Provide students an insight of various causes of natural resource depletion and its conservation 3. Provide detailed knowledge of causes, effects and control of different types of environmental pollution and its effect on climate change, global warming and ozone layer depletion. 4. Provide knowledge of different methods of water conservation 5. Provide and enrich the students about social issues such as R&R, population and sustainability.	
6	Course Outcomes	CO1.Understand the principles and scope of environmental science CO2. Study about various pollution causes, effects and control and solid waste management. CO3. Effect of global warming and ozone layer depletion CO4. Knowledge about various types of natural resources and its conservation CO5. Understand about sustainable development, resettlement and rehabilitation, impact of population explosion on environment the methods of water conservation CO6. Overall understanding of various environmental components, its protection and management.	
7	Course Description	Environmental Science emphasises on various factors as 1. Importance and scope of environmental science 2. Natural resource conservation 3. Pollution causes, effects and control methods 4. Social issues associated with environment	
8	Outline syllabus		CO Mapping
	Unit 1	**General Introduction**	
	A	Definition, principles and scope of environmental science	CO1/CO6
	B	Land resources, Forest Resources	CO1/CO6
	C	Water Resources ,Energy Resources	CO1/CO6

	Unit 2	**Environmental Pollution (Cause, effects and control measures) and solid waste management**			
	A	Air pollution ,Water Pollution			CO2/CO6
	B	Soil and Noise pollution			CO2/CO6
	C	Solid wastes and its management			CO2/CO6
	Unit 3	**Climate Change and its impact**			
	A	Concept of Global Warming and greenhouse effect			CO3/CO6
	B	Ozone layer Depletion and its consequences			CO3/CO6
	C	Climate change and its effect on ecosystem, Kyoto protocol and IPCC concerns on changing climate			CO3/CO6
	Unit 4	**Natural resource conservation**			
	A	Hot spots, threats to biodiversity, endemic species			CO4/CO6
	B	Conservation of biodiversity, ex-situ, in-situ conservation, biodiversity services.			CO4/CO6
	C	Need of Water Conservation, Rain Water Harvesting Watershed management			CO4/CO6
	Unit 5	**Social Issues and the Environment**			
	A	Concept of sustainable development			CO5/CO6
	B	Resettlement and rehabilitation of people; its problems and concerns, Case studies			CO5/CO6
	C	Population explosion and its consequences			CO5/CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Text book/s*	**1.** Joseph, Benny, "Environmental Studies", Tata Mcgraw-Hill.			
	Other References				

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

CO↓ PO→	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
C106.1	1	1	2	1	2	1	2	1	1	1
C106.2	1	1	2	1	2	1	2	2	1	1
C106.3	1	2	1	2	1	1	1	2	1	2
C106.4	2	1	2	1	2	1	2	1	1	2
C106.5	1	2	1	2	1	2	1	2	1	1
C106.6	2	1	2	1	2	2	1	2	2	1

DISCRETE MATHEMATICS (MSM 312)

School: SBSR		**Batch : 2020- 2023**
Program: B. Sc. (H)		**Current Academic Year: 2020-21**
Branch: Data Science		**Semester: I**
1	Course Code	MSM 312
2	**Course Title**	**DISCRETE MATHEMATICS**
3	Credits	4
4	Contact Hours (L-T-P)	3-1-0
	Course Status	Compulsory
5	Course Objective	This course is aimed to provide an advance understanding to the sets and propositions, relations and functions, permutation and combination, graphs, groups and rings.
6	Course Outcomes	CO1: Discuss the concept of sets, un-countably infinite sets, principle of inclusion and exclusion, multisets, propositions, conditional propositions and evaluate normal forms, Mathematical induction.(K2,K3, K4,K5) CO2: Describe the concept functions, composition of function, invertible functions, discrete properties of binary relations and check the closure of relations. (K3, K6) CO 3: Explain the concept of POSET and lattices, Warshall's algorithm, Equivalence relations and partitions and evaluate Chains, and Anti-chains. Generating Functions, Recurrence relations and discuss linear recurrence relations with constant coefficient, homogeneous solution, total solutions, solutions by method of Generating function. (K2, K4,K5) CO 4: Illustrate the concept permutations and combinations: rule of sum and product, write the algorithms for generation of permutations and combination. (K3, K5,K6) CO 5: Discuss the concept graph, sub-graph, Walks, Path and circuits, Connected graphs, Disconnected graphs and component, evaluate the fundamental circuits, distance, diameters, radius and pendant vertices, rooted and binary trees (K1,K2,K5,K6) CO6: Demonstrate the understanding of Algebraic systems, Group and evaluate Semi-groups, Monoid, Subgroups, Isomorphism and

		Automorphism. (K2, K5)	
7	Course Description	This course is given the deep knowledge of sets and propositions, relations and functions, permutation and combination, graphs, groups and rings.	
8	Outline syllabus :		CO Mapping
	Unit 1	**Sets and Propositions -**	
	A	Sets, Un-countably infinite sets, Principle of inclusion and exclusion, multisets, propositions,	CO1
	B	Conditional propositions. Logical connectivity, Propositional, calculus,	CO1, CO2
	C	Universal and existential quantifiers, Normal forms, methods of proofs, Mathematical induction.	CO2
	Unit 2	**Relations and Functions -**	
	A	Functions , Composition of function , invertible functions, Discrete properties of binary relations, closure of relations	CO3
	B	Warshall's algorithm, Equivalence relations and partitions, Ordered Sets and Lattices: Introduction, Ordered set,	CO3
	C	Hasse diagram of partially ordered set, Consistent enumeration, Isomorphic ordered set, Well ordered set, Lattices, Properties of lattices, Bounded lattices, Distributive lattices, and Complemented lattices. Chains, and Anti-chains.	CO3
	Unit 3	**Number Theory**	
	A	Counting: Basic counting principles, factorial notation, Binomial coefficients, Ordered and unordered partitions.	CO4
	B	Permutations and combinations : Rule of sum and Product, Permutations, Combination, Algorithms for Generation of Permutations and Combination,	CO4
	C	The Pigeonhole principle, Fundamental theorem of arithmetic, Congruence relation, Congruence Equations.	CO4
	Unit 4	**Recurrence Relations And Algebraic Structures**:	
	A	Discrete Numeric Functions and Generating functions,	CO5

	B	Simple Recurrence relation with constant coefficients			CO5
	C	Linear recurrence relations without constant coefficients, Asymptotic behavior of functions.			CO5
	Unit 5	**Algebraic Structures -**			
	A	Algebraic systems, Group, Semi-groups, Monoid, Subgroups.			CO6
	B	Cyclic group ,Permutation groups, Homomorphism,			CO6
	C	Isomorphism and Automorphism of groups.			CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Text book/s*	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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
C312.1	**3**	**3**	**2**	**2**	**2**	**2**	**2**	**2**	**1**	**1**
C312.2	**2**	**3**	**2**	**3**	**3**	**2**	**1**	**2**	**1**	**2**
C312.3	**2**	**3**	**2**	**2**	**2**	**2**	**2**	**1**	**2**	**2**
C312.4	**2**	**3**	**2**	**3**	**2**	**2**	**2**	**2**	**3**	**2**
C312.5	**3**	**3**	**2**	**2**	**2**	**1**	**2**	**2**	**2**	**2**
C312.6	**3**	**3**	**2**	**2**	**3**	**3**	**2**	**2**	**2**	**2**

Statistics I (BDA 101)

School: SBSR		**Batch: 2020- 2023**
Program: B. Sc. (H)		**Current Academic Year: 2020-21**
Branch: Data Science		**Semester: I**
1	Course Code.	BDA101
2	Course Title	STATISTICS I
3	Credits	4
4	Contact Hours (L-T-P)	3-0-1
	Course status	Compulsory
5	Course Objectives	1. To introduce basic statistical concepts, logics and analytical tools, analyze and communicate quantitative data verbally, graphically, symbolically and numerically. 2. To make students familiar with the concept of Probability and Statistics and display data by means of various tables, charts, and graphs.
6	Course Outcomes	CO1: Describe the process and particular steps in designing studies, collecting and analyzing data, interpreting and presenting results; and develop skills in presenting quantitative data using appropriate diagrams, tabulations and summaries. (K2, K5) CO2: Describe the properties of discrete and continuous distribution functions. (K2) CO3: Calculate the measures of central tendency and dispersion of a data and describe the method used for analysis, including a discussion of advantages, disadvantages, and necessary assumptions. (K2, K3) CO4: Calculate and interpret the correlation between two variables and Calculate the simple linear regression equation for a set of data and know the basic assumptions behind regression analysis. (K2, K3) CO5: Understand the line of best fit as a tool for summarizing a linear relationship and predicting future observed values, develop the ability to use formal mathematical argument in the context of probability. (K2, K5) CO6: Develop the skills to interpret the results of statistical analysis. (K2, K5)
7	Course Description	This is an introductory course in statistics. Students are introduced to the fundamental concepts involved in using sample data to make

		inferences about populations. Included are the study of measures of central tendency and dispersion, finite probability, statistical inferences from large and small samples, linear regression, and correlation.
8	Outline syllabus:	
UNIT 1	**Presentation of data**	CO Mapping
A	Classification, tabulation, diagrammatic & graphical representation of grouped data.	CO1, CO6
B	Frequency distributions, cumulative frequency distributions	CO1, CO2, CO6
C	Histogram, Ogives, frequency polygon, Tree and leaf diagram.	CO1, CO6
UNIT 2	**Descriptive statistics**	
A	Measures of central tendency – arithmetic mean, median, quartiles, mode, harmonic mean, geometric mean.	CO1, CO3, CO6
B	Their properties, merits and demerits	CO1, CO3, CO6
C	Measures of dispersion – range, quartile deviation, mean deviation, standard deviation and coefficient of variation.	CO1, CO3, CO6
UNIT 3	**Moments**	
A	Moments, Skewness, Measures of skewness: Karl Pearson's coefficient of skewness.	CO1, CO3, CO6
B	Quartile coefficient of skewness, Measure of skewness based on moments.	CO1, CO3, CO6
C	Kurtosis, measure of Kurtosis.	CO1, CO3, CO6
UNIT 4	**Bi-variate data analysis**	
A	Bivariate data, principles of least squares, fitting of polynomial curves and fitting of curves reducible to polynomial form.	CO1, CO4, CO6
B	Correlation: Spearman's rank correlation, Partial and Multiple Correlation (only two independent variables case).	CO1, CO4, CO6
C	Regression lines.	CO1, CO4, CO5, CO6
UNIT 5	**Probability**	
A	Probability: Introduction, random experiment, outcomes, sample space, events, various definitions of probability, laws of total and compound probability. Boole's inequality. Conditional probability, independence of events. Bayes theorem and its applications.	CO1, CO5, CO6
B	Random variables: discrete and continuous random variables,	CO1, CO5, CO6

	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, univariate transformations with illustrations.	
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, CO5, CO6

	Mode of Examination	Theory		
	Weightage distribution	CA	MTE	ETE
		30%	20%	50%

	Text books	1. 1. Gupta,S.C and Kapoor,V.K, "Fundamental of Mathematical Statistics".
	Other references	1. Daniel,WayneW.,"Biostatistics": Basic concept and Methodology for Health Science. 2. Grewal,B.S, "Higher Engineering Mathematics".

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
C101.1	**3**	**3**	**2**	**2**	**2**	**3**	**2**	**2**	**1**	**1**
C101.2	**2**	**3**	**3**	**3**	**3**	**2**	**1**	**2**	**1**	**2**
C101.3	**2**	**3**	**2**	**2**	**2**	**2**	**1**	**1**	**2**	**2**
C101.4	**2**	**2**	**2**	**3**	**2**	**2**	**1**	**2**	**2**	**2**
C101.5	**3**	**2**	**2**	**3**	**2**	**1**	**2**	**1**	**2**	**1**
C101.6	**3**	**3**	**2**	**2**	**3**	**3**	**2**	**1**	**2**	**2**

School: SBSR		**Batch: 2020-2023**	
Program: B. Sc.(H)		**Current Academic Year: 2020-21**	
Branch: Data Science		**Semester: I**	
1	Course Code.	BDA 104	
2	**Course Title**	**Programming R**	
3	Credits	4	
4	Contact Hours (L-T-P)	2-0-1	
	Course status	Compulsory	
5	Course Objectives	To familiarise students with basics programming in R, and its applications in data analysis.	
	Course Outcomes	CO1: Explain the R Windows Environment and describe various data types. (K1, K2, K3, K4) CO2: Explain and describe Outliers, Combining Datasets. (K2, K3) CO3: Explain and illustrate R Functions and loops, Summary Statistics –Summarizing data with R. (K2,K3, K4). CO4: Discuss how to load data, plot a graph and illustrate different types of graphs with graphical summaries of data. (K2, K3, K4) CO5: Discuss how to generate automated reports giving detailed basic statistics using R and evaluate measures of central tendency and dispersion. Covariance, correlation and lines of regression in R.(K2, K3, K4) CO6: Explain fitting of polynomials and exponential curves and illustrate Normal probability plot. (K 4, K6)	
7	Course Description	This course is an introduce basics programming in R, and its applications in data analysis.	
8	Outline syllabus Programming R		CO Mapping
	Unit 1		
	A	Introduction to R, R-Studio (GUI): R Windows Environment, introduction to various data types,	CO1
	B	Numeric, Character, date, data frame, array, matrix etc.,	CO1
	C	Reading Datasets, Working with different file types .txt, .csv etc.	CO1

	Unit 2				
	A	Outliers, Combining Datasets,			CO2
	B	R Functions and loops,			CO2
	C	Summary Statistics –Summarizing data with R.			CO3
	UNIT 3				
	A	Vector space and subspace of vector space.			CO4
	B	Linear dependence and independence of vectors, linear span.			CO4
	C	Basis and dimension, sums and direct sums.			CO4
	Unit 4				
	A	Learn how to load data, plot a graph viz.			CO5
	B	histograms (equal class intervals and unequal class intervals), box plot, stem-leaf, frequency polygon, pie chart, ogives with graphical summaries of data,			CO5
	C	customization of plot setting, adding text, saving to a file, adding a legend.			CO5
	Unit 5				
	A	Random number generation and sampling procedures.			CO6
	B	Fitting of polynomials and exponential curves.			CO6
	C	Application Problems based on fitting of suitable distribution, Normal probability plot.			CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Text book/s*	1. Gardener, M (2012): Beginning R: The Statistical Programming Language, Wiley Publications. 2. Braun W J, Murdoch D J (2007): A First Course in Statistical Programming with R. Cambridge University Press. New York			
	Other References	1. Crawley, M.J. (2015): Statistics: An Introduction Using R, 2nd Edition. Wiley. 2. Crawley, M.J. (2012): The R Book, 2nd Edition. Wiley.			

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
C104.1	3	3	2	2	2	3	2	2	2	2
C104.2	3	3	3	3	3	2	3	2	2	2
C104.3	2	3	2	2	2	2	2	2	2	2
C104.4	2	2	2	3	2	2	1	2	2	2
C104.5	3	2	2	3	2	3	2	2	2	2
C104.6	3	3	2	2	3	3	2	1	2	2

Linear Algebra (MSM 106)

School: SBSR		**Batch: 2019- 2022**
Program: B. Sc.(H)		**Current Academic Year: 2019-20**
Branch: Mathematics		**Semester: II**
1	Course Code.	MSM 106
2	**Course Title**	**LINEAR ALGEBRA**
3	Credits	4
4	Contact Hours (L-T-P)	3-1-0
	Course status	Compulsory
5	Course Objectives	To familiarise students with basics algebra of matrices, and its applications, vector space, Linear transformation and its properties, matrix representation of a linear transformation.
	Course Outcomes	CO1: Describe the concept of algebra of matrices and elementary row operations and calculate the rank of matrix and analyse consistency of a linear system. (K1, K2, K3, K4) CO2: Calculate the eigenvalues, eigenvectors, diagonalization of a matrix. (K2, K3) CO3: Explain and illustrate Cayley - Hamilton theorem and its applications. (K2,K3, K4).

		CO4: Discuss vector space and subspace, explain linear dependence and independence of vectors and calculate linear span, basis and dimension, sums and direct sums. (K2, K3, K4) CO5: Discuss about linear transformation and its properties, range and kernel of a linear transformation, calculate the rank and nullity of linear transformation and drive Rank-nullity theorem and explain inverse of linear transformation, operations with linear transformations.(K2, K3, K4) CO6: Explain matrix representation of a linear transformation and general linear transformations; evaluate change of basis, similarity of matrices. (K 4, K6)	
7	Course Description	This course is an introduce basics algebra of matrices, and its applications, vector space, Linear transformation and its properties, matrix representation of a linear transformation.	
8	Outline syllabus Linear Algebra		CO Mapping
	Unit 1	**Algebra of matrices-1**	
	A	Algebra of matrices, elementary row operations	CO1
	B	Row reduced Echelon form, rank of a matrix	CO1
	C	Consistency of a linear system, inverse of a matrix (using elementary row operations.	CO1
	Unit 2	**Algebra of matrices-2**	
	A	Eigenvalues and eigenvectors	CO2
	B	Diagonalization of a matrix	CO2
	C	Cayley - Hamilton theorem (without proof) and its applications	CO3
	UNIT 3	**Vector Spaces**	
	A	Vector space and subspace of vector space.	CO4
	B	Linear dependence and independence of vectors, linear span.	CO4
	C	Basis and dimension, sums and direct sums.	CO4
	Unit 4	**Linear Transformation- 1**	
	A	Linear transformation and its properties.	CO5
	B	Range and kernel of a linear transformation, rank and nullity of linear transformation.	CO5
	C	Rank-nullity theorem, inverse of linear transformation, operations with linear transformations.	CO5
	Unit 5	**Linear Transformation- 2**	

	A	Matrix representation of a linear transformation			CO6
	B	Change of basis, similarity			CO6
	C	Matrices and general linear transformations.			CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Text book/s*	1. Hoffman, K &Kunze, R. , Linear Algebra, 2nd edition, Prentice Hall of India, 1975. 2.Lipshutz, S., Lipsom, M., Linear algebra, 3rd edition, Schaum series, 2001.			
	Other References	1. Strang, G., Linear Algebra and its applications, 3rd edition, Thomson,1998. 2. Kreyszig , E., Advanced Engineering Mathematics, John Wiley & Sons. 3. V. Krishnamurthy, V.P. Mainra and J.L. Arora: An Introduction to Linear Algebra.			

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
C106.1	**3**	**3**	**2**	**2**	**2**	**3**	**2**	**2**	**1**	**1**
C106.2	**2**	**3**	**3**	**3**	**3**	**2**	**1**	**2**	**1**	**2**
C106.3	**2**	**3**	**2**	**2**	**2**	**2**	**1**	**1**	**2**	**2**
C106.4	**2**	**2**	**2**	**3**	**2**	**2**	**1**	**2**	**2**	**2**
C106.5	**3**	**2**	**2**	**3**	**2**	**1**	**2**	**1**	**2**	**1**
C106.6	**3**	**3**	**2**	**2**	**3**	**3**	**2**	**1**	**2**	**2**

School: SBSR		Batch : 2020- 2023
Program: B. Sc. (H)		Current Academic Year: 2020-21
Branch: Date Science		Semester: II
1	Course Code	BDA 105
2	**Course Title**	**Statistics II**
3	Credits	3
4	Contact Hours (L-T-P)	3-0-0
	Course Status	Compulsory
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 population mean and total, variances of these estimates along with the brief of present official statistical system in India, methods of collection of official statistics, their reliability and limitations has 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 population mean, explain its application and estimates of theses variances and sample size determination. (K2, K3, K4) CO4: Describe stratified random sampling, estimates of 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 correlation coefficient between X and Y for regression method and their comparison with SRS. (K2, K3, K6) CO6: Describe and analyze the basic concepts present official statistical system in India, methods of collection of official statistics. (K1,K2, K4)
7	Course Description	This course is an initiate the advance concept of sample and population, complete enumeration versus sampling. The concept of Systematic Sampling, estimates of population mean and total, variances of these estimates along with the brief of present official

		statistical system in India, methods of collection of official statistics, their reliability and limitations has been introduced. .
8	Outline syllabus : **Statistics -II**	CO Mapping
	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 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 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 population mean and total, variances of these estimates.	CO4
	Unit 4	
	A	Ratio and regression methods of estimation, estimates of 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 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 responsible for data collection and their main functions.			CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Text book/s*	1. Goon A.M., Gupta M.K. and Dasgupta B (2001): Fundamentals of Statistics (Vol.2), Word Press. 2. Murthy M.N. (1977): Sampling Theory & Statistical Methods, Statistical Pub. Society, Calcutta 3. Des Raj and Chandhok P.(1998): Sample Survey Theory, Narosa Publishing House. 4. Cochran W.G (1984):Sampling Techniques (3rd Ed.), Wiley Eastern.			
	Other References	1. Mukhopadhyay P.(1998): Theory and Methods of Survey Sampling, Prenctice Hall 2. Sampat S.(2001): Sampling Theory and Methods, Narosa Publishing House 3. Guide to current Indian Official Statistics, Central Statistical Organization , GOI,New Delhi. 4. Saluja,M.P. (1972): Indian official statistical systems, Statistical Pub. Society, Calcutta.			

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
C105.1	3	3	2	2	2	3	2	2	1	1
C105.2	2	3	3	3	2	2	2	2	1	2
C105.3	2	3	2	2	3	2	1	1	2	2
C105.4	2	2	2	3	2	2	1	2	2	2
C105.5	3	2	2	3	2	1	2	1	2	1
C105.6	3	3	2	2	3	3	2	1	2	1

School: SBSR		Batch: 2020- 2023
Program: B. Sc. (H)		Current Academic Year: 2020-21
Branch: Data Science		Semester: II
1	Course Code.	BDA 106
2	Course Title	STATISTICS III
3	Credits	4
4	Contact Hours (L-T-P)	3-0-1
	Course status	Compulsory
5	Course Objectives	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 Statistical analysis of descriptive statistics, 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, construction of confidence intervals using 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 test, develop the ability to use one sample t-test, two-sample t-test, 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 Z-test, F-test, 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:			
UNIT 1				CO Mapping
A	Statistical analysis of descriptive statistics, principle of least square, lines of regression, simple linear regression			CO1
B	coefficient of determination. Multiple linear regression, coefficient of multiple determination.			CO1
C	Fitting of polynomials and exponential curves.			CO2
UNIT 2				
A	Criteria for obtaining a good estimator: unbiasedness, consistency, efficiency, sufficiency.			CO3
B	Minimal sufficient statistic.			CO3
C	Uniformly minimum variance unbiased estimator, complete statistic.			CO3
UNIT 3				
A	Method of point estimation: Method of moments, maximum likelihood estimator and its properties, mean square error (MSE).			CO4
B	Interval estimation: Confidence interval, construction of confidence intervals using pivotal			CO4
C	Shortest expected length confidence interval.			CO4
UNIT 4				
A	Null hypothesis, alternative hypothesis, type I error, type II error, level of significance, p-value and power of test.			CO5
B	Tests for mean based on normal distribution – one sample t-test, two-sample t-test, paired-sample t-test.			CO5
C	Tests for variance based on normal distribution – one sample and two-sample problem			CO5
UNIT 5				
A	The large sample size test: Z-test, F-test,			CO6
B	Chi-square test for goodness of fit.			CO6
C	One-way and Two-way analysis of variance (ANOVA) techniques.			CO6
	Mode of Examination	Theory		
	Weightage distribution	CA	MTE	ETE
		30%	20%	50%

	Text books	2. 1. Gupta,S.C and Kapoor,V.K, "Fundamental of Mathematical Statistics".
	Other references	3. Daniel,WayneW.,"Biostatistics": Basic concept and Methodology for Health Science. 4. Grewal,B.S, "Higher Engineering Mathematics".

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
C106.1	3	3	2	2	2	3	2	1	1	1
C106.2	2	3	3	3	3	2	1	2	1	2
C106.3	2	3	2	2	2	2	1	2	2	2
C106.4	2	2	2	3	2	2	1	2	2	2
C106.5	3	2	2	3	2	1	2	1	2	2
C106.6	3	3	2	2	3	3	2	2	2	2

School: SBSR		**Batch : 2020- 2023**	
Program: B.Sc.(H)		**Current Academic Year: 2020-21**	
Branch: Data Science		**Semester: II**	
1	Course Code	BDA-111	
2	**Course Title**	**Introduction to MATLAB in data analysis**	
3	Credits	4	
4	Contact Hours (L-T-P)	2-0-2	
	Course Status	Compulsory	
5	Course Objective	The goal of this course is to introduce the necessary mathematical concepts for MATLAB and cover the syntax and semantics of MATLAB including control structures, comments, variables, functions etc. Once the foundations of the language have been established students will explore different types of scientific programming problems including curve fitting, ODE solving etc.	
6	Course Outcomes	CO1: Describe the fundamentals of MATLAB and use MATLAB for interactive computations. (K2, K3) CO2: Demonstrate with strings and matrices and their uses. (K2, K3) CO3: Illustrate basic flow controls (if-else, for, while). (K3) CO4: Create plots and export this for use in reports and presentations. (K3, K5) CO5: Develop program scripts and functions using the MATLAB development environment. (K4, K5) CO6: Write the program for evaluates linear system of equations, enhance data analysis using MATLAB. (K5,K6)	
7	Course Description	The course will give the fundamental knowledge and practical abilities in MATLAB required to effectively utilize this tool in technical numerical computations and visualisation in other courses. Syntax and interactive computations, programming in MATLAB using scripts and functions, rudimentary algebra and analysis. One- and two-dimensional graphical presentations. Examples on engineering applications.	
8	Outline syllabus	**Introduction to MATLAB**	CO Mapping
	Unit 1	**Introduction**	
	A	Vector and matrix generation, Subscripting and the colon notation.	CO1
	B	Matrix and array operations and their manipulations,	CO1
	C	Introduction to some inbuilt functions.	CO1
	Unit 2	**Relational and Logical Operators**	
	A	Flow control using various statement and loops including If-End statement, If-Else –End statement	CO1, CO3

	B	Nested If-Else-End Statement,			CO3
	C	For – End and While-End loops with break commands.			CO3
	Unit 3	**m-files**			
	A	Scripts and functions			CO2,CO5
	B	concept of local and global variable			CO2,CO5
	C	few examples of in-built functions, editing, saving m-files.			CO2,CO5
	Unit 4	**Two dimensional Graphics**			
	A	Basic Plots, Change in axes and annotation in a figure			CO4
	B	multiple plots in a figure			CO4
	C	saving and printing figures			CO4
	Unit 5	**Applications of MATLAB**			
	A	Solving a linear system of equations,			CO5, CO6
	B	Reading Excel Data into MATLAB, Saving Data from MATLAB to Excel Using a Template			CO5, CO6
	C	Enhancing Data Analysis with MATLAB			CO5, CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Text book	An introduction to MATLAB : Amos Gilat			
	Other References	1. Applied Numerical Methods with Matlab for engineering and Scientists by stevenchapra, Mcgraw Hill. 2. Getting started with Matlab: RudraPratap			

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
C111.1	3	3	2	2	2	3	2	2	1	2
C111.2	2	3	3	3	3	2	1	2	2	2
C111.3	2	3	2	2	2	2	2	1	2	2
C111.4	2	2	2	3	2	2	2	2	2	2
C111.5	3	2	2	3	2	2	2	3	2	2
C111.6	3	3	2	3	3	3	2	2	2	2

Program: B. Sc. (H)		Current Academic Year: 2020-21	
Branch: Data Science		**Semester: II**	
1	Course Code	BDA 107	
2	Course Title	Differential Equations & Complex Variable	
3	Credits	4	
4	Contact Hours (L-T-P)	3-1-0	
	Course Status	Compulsory	
5	Course Objective	To Familiarise students with basic concepts of ordinary differential equations. Learn to solve first-order differential equations. Explore the methods to solve Linear differential equation of nth order with constant coefficients. Complex Variable – Differentiation and integration.	
6	Course Outcomes	CO1: Explain the classification of ordinary differential equations according to order and linearity. (K2, K4) CO2: Demonstrate several methods like equations solvable for p, equations solvable for y, equations solvable for x and Clairaut's type. (K2, K3) CO3: Solve second order and higher order linear differential equations. (K3) CO4: Describe the solution of complex differentiation, Cauchy-Riemann equations, analytic functions and explain conformal mappings, Mobius transformations and their properties. (K2, K3) CO5: Discuss working rule for finding contour integrals, Cauchy-Goursat theorem, Cauchy Integral formula. (K3, K6) CO6: Discuss Taylor's series, zeros of analytic functions, singularities, Laurent's series; Residues, Cauchy Residue theorem, and evaluate definite integral involving sine and cosine, improper integrals using the Bromwich contour. (K2, K6)	
7	Course Description	This course covers basic concepts of ordinary differential equations. Learn to solve first-order differential equations. Explore the methods to solve Linear differential equation of nth order with constant coefficients. Complex Variable – Differentiation and integration.	
8	Outline syllabus		CO Mapping
	Unit 1		
	A	Exact, linear and Bernoulli's equations, Euler's equations,	CO1
	B	Equations not of first degree: equations solvable for p, equations solvable for y.	CO2
	C	Equations solvable for x and Clairaut's type.	CO2
	Unit 2		
	A	Second order linear differential equations with variable coefficients, method of variation of parameters.	CO1, CO3
	B	Cauchy-Euler equation; Power series solutions; Legendre polynomials.	CO3
	C	Bessel functions of the first kind and their properties.	CO3
	Unit 3		

	A	Differentiation, Cauchy-Riemann equations, analytic functions, harmonic functions, finding harmonic conjugate;			CO4
	B	elementary analytic functions (exponential, trigonometric, logarithm) and their properties;			CO4
	C	Conformal mappings, Mobius transformations and their properties			CO4
	Unit 4				
	A	Contour integrals, Cauchy-Goursat theorem (without proof),			CO5
	B	Cauchy Integral formula (without proof), Liouville's theorem			CO5
	C	Maximum-Modulus theorem (without proof);			CO5
	Unit 5				
	A	Taylor's series, zeros of analytic functions, singularities, Laurent's series; Residues,			CO6
	B	Cauchy Residue theorem (without proof), Evaluation of definite integral involving sine and cosine,			CO6
	C	Evaluation of certain improper integrals using the Bromwich contour.			CO6
	Mode of examination	Theory/Jury/Practical/Viva			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Text book/s*	1. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008. 2. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 36th Edition, 2010.			
	Other References	1. G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, 9th Edition, Pearson, Reprint, 2002. 2. Erwin kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006. 3. W. E. Boyce and R. C. DiPrima, Elementary Differential Equations and Boundary Value Problems, 9th Edn., Wiley India, 2009.			

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
C107.1	2	2	2	2	2	3	2	2	1	1
C107.2	2	3	3	2	3	2	1	2	1	2
C1074.3	2	3	2	2	2	2	2	1	2	2
C107.4	2	2	2	3	2	2	1	2	2	2
C107.5	3	2	2	3	2	1	2	2	2	3
C107.6	3	2	2	2	3	3	2	2	2	2

Introduction to Computer Organization (BDA 108)

School: SBSR		**Batch : 2020- 2023**
Program: B. Sc. (H)		**Current Academic Year: 2020-21**
Branch: Data Science		**Semester: II**
1	Course Code	BDA 108
2	**Course Title**	**Introduction to Computer Organization**
3	Credits	3
4	Contact Hours (L-T-P)	3-0-0
	Course Status	Compulsory
5	Course Objective	To make students familiar with the Computer Organization. The concept of basic digital building blocks; truth tables; Characters-ASCII coding, other coding schemes; External interface, Memory Subblock, Memory organization, Introduction to Advanced Processors.
6	Course Outcomes	CO1: Explain and illustrate the concepts truth tables; basic structure of a digital computer, Number representation, Integer -unsigned, signed. (K2, K3, K4) CO2: Describe the Characters of ASCII coding, other coding schemes; Real numbers-_xed and oating point and assembly language programming for some processor. (K1, K2, K3, K5) CO3: Describe the basic building blocks for the ALU, Adder, Subtractor, Shifter, Multiplication and division circuits. (K2, K3, K4) CO4: Describe CPU Subblock, Datapath - ALU, registers, CPU buses; Control path microprogramming (only the idea), hardwired, logic. (K2, K3, K4) CO5: Describe the External interface, Memory Subblock, Memory organization and explain Synchronous vs.Asynchronous I/ O; Controllers. (K2, K3) CO6: Explain Peripherals, Disk drives; Printers- impact, dot matrix, ink jet, laser and Introduction to Advanced Processors (K1,K2, K4)

7	Course Description	This course an introduce the computer organization. The concept of basic digital building blocks; truth tables; Characters-ASCII coding, other coding schemes; External interface, Memory Subblock, Memory organization, Introduction to Advanced Processors.	
8	Outline syllabus :		CO Mapping
	Unit 1		
	A	Introduction, Overview of basic digital building blocks;	CO1
	B	truth tables; basic structure of a digital computer, Number representation,	CO1
	C	Integer -unsigned, signed (sign magnitude, 1s complement, 2s complement, rs complement)	CO1
	Unit 2		
	A	Characters-ASCII coding, other coding schemes;	CO2
	B	Real numbers-_xed and oating point,	CO2
	C	IEEE754, Assembly language programming for some processor	CO2
	Unit 3		
	A	Basic building blocks for the ALU, Adder, Subtractor, Shifter,	CO3
	B	Multiplication and division circuits, CPU Subblock, Datapath - ALU,	CO3
	C	Registers, CPU buses; Control path microprogramming (only the idea), hardwired, logic	CO4
	Unit 4		
	A	External interface, Memory Subblock, Memory organization; Technology-ROM, RAM, EPROM, Flash etc. Cache;	CO5
	B	Cache coherence protocol for uniprocessor (simple), I/O Subblock, I/O techniques -interrupts, polling, DMA;	CO5
	C	Synchronous vs.Asynchronous I/ O; Controllers	CO5

	Unit 5				
	A	Peripherals, Disk drives; Printers- impact,			CO6
	B	dot matrix, ink jet, laser; Plotters; Keyboards; Monitors;			CO6
	C	Advanced Concepts, Pipelining; Introduction to Advanced Processors.			CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Text book/s*	1. Computer Organization – Carl Hamacher, Zvonks Vranesic, SafeaZaky, Vth Edition, McGraw Hill. 2. Computer Systems Architecture – M.Moris Mano, IIIrd Edition, Pearson/PHI			
	Other References	1. Computer Organization and Architecture – William Stallings Sixth Edition, Pearson/PHI 2. Structured Computer Organization – Andrew S. Tanenbaum, 4th Edition PHI/Pearson 3. Fundamentals or Computer Organization and Design, – Sivaraama, Dandamudi Springer Int. Edition			

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
C108.1	2	2	2	3	2	2	2	3	2	2
C108.2	2	2	3	3	2	2	2	2	2	2
C108.3	2	3	2	2	2	2	1	2	2	2
C108.4	2	2	2	3	2	2	2	2	2	2
C108.5	3	2	3	3	2	2	2	1	2	1
C108.6	3	2	2	2	3	2	2	1	2	2

Data Structure & Algorithms (BDA 110)

School: SBSR		**Batch : 2020- 2023**
Program: B. Sc. (H)		**Current Academic Year: 2020-21**
Branch: Data Science		**Semester: II**
1	Course Code	BDA 110
2	**Course Title**	**Data Structure & Algorithms**
3	Credits	4
4	Contact Hours (L-T-P)	3-0-1
	Course Status	Compulsory
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 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 an introduce 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	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.	CO3
	Unit 3		
	A	**Stacks and Queues**: ADT Stack and its operations: Algorithms and their complexity analysis,	CO4
	B	Applications of Stacks: Expression Conversion and	CO4

		evaluation – corresponding algorithms and complexity analysis.			
	C	ADT queue, Types of Queue: Simple Queue, Circular Queue, Priority Queue; Operations on each types of Queues: Algorithms and their analysis.			CO4
	Unit 4				
	A	**Linked Lists:** Singly linked lists: Representation in memory, Algorithms of several operations: Traversing, Searching, Insertion into, Deletion from linked list;			CO5
	B	Linked representation of Stack and Queue, Header nodes, Doubly linked list: operations on it and algorithmic analysis; Circular Linked Lists: all operations their algorithms and the complexity analysis.			CO5
	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				
	A	**Sorting and Hashing:** Objective and properties of different sorting algorithms: Selection Sort, Bubble Sort, Insertion Sort, Quick Sort, Merge Sort, Heap Sort;			CO6
	B	Performance and Comparison among all the methods, Hashing.			CO6
	C	**Graph:** Basic Terminologies and Representations, Graph search and traversal algorithms and complexity analysis.			CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	

	Text book/s*	1. Fundamentals of Data Structures", Illustrated Edition by Ellis Horowitz, SartajSahni, Computer Science Press.	
	Other References	2. Algorithms, Data Structures, and Problem Solving with C++", Illustrated Edition by Mark Allen Weiss, Addison-Wesley Publishing Company. 3. How to Solve it by Computer", 2nd Impression by R. G. Dromey, Pearson Education.	

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
C110.1	3	2	2	3	2	2	2	3	2	1
C110.2	2	2	3	3	2	2	2	2	1	2
C110.3	2	3	2	2	3	2	1	2	2	2
C110.4	2	2	2	3	2	2	2	2	2	2
C110.5	3	2	3	3	2	1	2	1	2	1
C110.6	3	2	2	2	3	2	2	1	2	2

Numerical Analysis (MSM 213)

School: SBSR		**Batch : 2019- 2022**	
Program: B.Sc. (H)		**Current Academic Year: 2020-21**	
Branch: Mathematics		**Semester: IV**	
1	Course Code	MSM 213	
2	**Course Title**	**Numerical Analysis**	
3	Credits	4	
4	Contact Hours (L-T-P)	3-1-0	
	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	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/Jury/Practical/Viva			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Text book/s*	1) An Introduction to Numerical Analysis by EndreSuli, David F. Mayers, Cambridge University Press, 2003. 2) Applied Numerical Analysis by C. F. Gerald, Pearson Education, 2009. 3) Elements of Numerical Analysis by R. S. Gupta, Macmillan India Ltd, 2009.			
	Other References	1) Numerical methods in Engineering & Science by B. S. Grewal, Khanna Publishers, 2013. 2) Numerical methods for Scientific and Engineering Computation by Jain, Iyengar, Jain, New Age International Publishers, 2004.			

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
C213.1	3	3	2	2	2	3	2	2	2	1
C213.2	2	3	3	3	3	2	1	2	2	2
C213.3	2	3	2	2	2	2	2	2	2	2
C213.4	2	2	2	3	2	2	2	2	2	1
C213.5	2	3	2	2	2	2	1	1	2	1
C213.6	3	3	2	2	2	2	2	1	1	2

DATA PREPARATION AND DATA CLEANING (BDA 201)

School: SBSR		**Batch : 2020- 2023**	
Program: B. Sc. (H)		**Current Academic Year: 2021-22**	
Branch: Data Science		**Semester: III**	
1	Course Code	BDA 201	
2	Course Title	Data preparation and Data Cleaning	
3	Credits	4	
4	Contact Hours (L-T-P)	3-0-1	
	Course Status	Compulsory	
5	Course Objective	To make students familiar with the concepts of preparing your data; Working with dates and times, Data Cleaning, Data Structure, Cleaning Text Data.	
6	Course Outcomes	CO1: Describe preparing data: Rearranging and removing variables, Renaming variables, Variable classes, Calculating new numeric variables and explain how to Dividing a continuous variable into categories, Working with factor variables. (K1, K3) CO2: Discuss how to working 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, sorting a dataset. (K2, K3, K4) CO3: Explain the data cleaning and technical representation of data. (K2,K3, K4) CO4: Discuss about 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 is an introduces preparing your data; Working with dates and times, Data Cleaning, Data Structure, Cleaning Text Data..	
8	Outline syllabus		CO Mapping
	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	CO1

		character strings, Extracting a substring, Searching a character variable.	
	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, Output.	CO3
	B	Technical Representation of Data: Numeric Data, Integers, Integers in R, Real Numbers, Double Precision Numbers, The Concept of Machine Precision, Consequences of Working with Floating Point Numbers, Dealing with the Consequences,	CO3
	C	Numeric Data in R, Text Data, Terminology and Encodings, Unicode, Textual Data in R: Objects of Class Character, Encoding in R, Reading and Writing of Data with Non-Local Encoding, Detecting Encoding, Collation and Sorting, Times and Dates. Time and Date Notation, Time and Date Storage in R, Time and Date Conversion in R, Leap Days, Time Zones, and Daylight Saving Times.	CO3
	Unit 4		
	A	**Data Structure:** Introduction, Tabular Data, data.frame, Databases, dplyr, Matrix Data, Time Series,	CO4
	B	Graph Data, Web Data, Web Scraping, Web API, Other Data, Tidying Tabular Data,	CO4
	C	Variable Per Column, Single Observation Stored in Multiple Tables.	CO4
	Unit 5		
	A	Cleaning Text Data: Character Normalization, Encoding Conversion and Unicode Normalization, Character Conversion and Transliteration,	CO5, CO6
	B	Pattern Matching with Regular, Expressions, Basic Regular Expressions, Practical Regular Expressions, Generating Regular Expressions in R,	CO5, CO6
	C	Common String Processing Tasks in R, Approximate Text Matching, String Metrics, String Metrics and Approximate Text Matching in R.	CO5, CO6
	Mode of	Theory	

	examination				
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
C201.1	3	3	2	3	2	3	2	2	1	2
C201.2	2	3	3	3	3	2	1	2	1	2
C201.3	2	3	2	2	2	2	2	2	3	2
C201.4	2	2	3	3	2	2	1	2	2	2
C201.5	2	2	1	2	2	2	2	2	2	2
C201.6	3	3	2	2	3	3	2	2	2	2

DATABASE MANAGEMENT SYSTEMS (BDA 202)

School: SBSR		**Batch : 2020- 2023**
Program: B.Sc. (H)		**Current Academic Year: 2021-22**
Branch: Data Science		**Semester: III**
1	Course Code	BDA 202
2	**Course Title**	**DATABASE MANAGEMENT SYSTEMS**
3	Credits	4
4	Contact Hours (L-T-P)	3-0-1
	Course Status	Compulsory
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, 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, database recovery management. (K2, K4, K5)
7	Course Description	This course is an introduce 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 : **DATABASE MANAGEMENT SYSTEMS**		CO Mapping
	Unit 1	**Introduction to Databases and Transactions and Data Models**	
	A	What is database system, purpose of database system, 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	**Unit-IV Constraints, Views and SQL**	
	A	What is constraints, types of constrains, Integrity constraints.	CO4

	B	Views: Introduction to views, data independence, security, updates on views, comparison between tables.			CO4
	C	Views SQL: data definition, aggregate function, Null Values, nested sub queries, Joined relations. Triggers.			CO4
	Unit 5	**Unit-V 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	MTE	ETE	
		30%	20%	50%	
	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 3 "Foundations of Databases", Reprint by Serge Abiteboul, Richard Hull, VictorVianu, Addison-Wesley			

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
C202.1	3	3	2	2	2	3	1	2	1	2
C202.2	2	3	3	3	3	2	1	2	1	2
C202.3	2	3	2	2	2	2	2	2	2	2
C202.4	2	2	2	3	2	2	2	3	2	2
C202.5	3	2	2	3	2	1	2	2	1	1
C202.6	3	2	3	2	3	2	2	2	1	1

Operating Systems (BDA 204)

School: SBSR		**Batch: 2020- 2023**
Program: B.Sc. (H)		**Current Academic Year: 2021-22**
Branch: Data Science		**Semester: III**
1	Course Code	BDA 204
2	**Course Title**	**OPERATING SYSTEMS**
3	Credits	4
4	Contact Hours (L-T-P)	3-0-1
	Course Code	Compulsory
5	Course Objective	To familiarise students with basic concepts of Operating Systems, Process Management Processes, Interprocess Communication Race Conditions, Deadlocks, Memory Management, I/O Management Principles of I/O Hardware, File Management.
6	Course Outcomes	CO1: Describe the concept of operating systems and process management processes. (K2) CO2: Explain the concept of interprocess communication race conditions, deadlocks (K2, K4) CO3: Recognize and decide basic memory management and virtual memory. (K1, K6) CO4: Define and discriminate I/O Management Principles of I/O Hardware and I/O Software. (K1, K6) CO5: Discuss about file management and directory implementation efficiency & performance. (K1,K2,K5) CO6:Explain Unix/Linux operating system and development of Unix/Linux. (K2,K4, K6)
7	Course Description	This course will cover basic concepts of Operating Systems, Process Management Processes, Interprocess Communication Race Conditions, Deadlocks, Memory Management, I/O Management Principles of I/O Hardware, File Management.
8	Outline syllabus		CO Mapping
	Unit 1		
	A	Introduction: Basics of Operating Systems: Definition – Generations of Operating systems – Types of Operating Systems, OS Service, System Calls, OS structure: Layered, Monolithic, Microkernel Operating Systems – Concept of Virtual Machine.	CO1
	B	Process Management Processes: Definition , Process	CO1

		Relationship , Process states , Process State transitions , Process Control Block ,Context switching – Threads – Concept of multithreads , Benefits of threads – Types of threads	
	C	Process Scheduling: Definition , Scheduling objectives ,Types of Schedulers ,Scheduling criteria : CPU utilization, Throughput, Turnaround Time, Waiting Time, Response Time (Definition only) , Scheduling algorithms : Pre emptive and Non , pre emptive , FCFS – SJF – RR , Multiprocessor scheduling : Types , Performance evaluation of the scheduling	CO1
	Unit 2		
	A	Interprocess Communication Race Conditions, Critical Section, Mutual Exclusion, Hardware Solution, Strict Alternation , Peterson's Solution,	CO2
	B	The Producer Consumer Problem, Semaphores, Event Counters, Monitors, Message Passing, Classical IPC Problems: Reader's & Writer Problem, Dinning Philosopher Problem etc., Scheduling , Scheduling Algorithms.	CO2
	C	Deadlocks: Definition,Deadlock characteristics , Deadlock Prevention , Deadlock Avoidance :banker's algorithm, Deadlock detection and Recovery	CO2
	Unit 3		
	A	Memory Management Basic Memory Management: Definition ,Logical and Physical address map , Memory allocation : Contiguous Memory allocation – Fixed and variable partition – Internal and External fragmentation and Compaction ,	CO3
	B	Paging : Principle of operation – Page allocation – Hardware support for paging –,Protection and sharing – Disadvantages of paging.	CO3
	C	Virtual Memory: Basics of Virtual Memory – Hardware and control structures – Locality of reference, Page fault , Working Set , Dirty page/Dirty bit – Demand paging (Concepts only) – Page Replacement policies : Optimal (OPT) , First in First Out (FIFO), Second Chance (SC), Not recently used (NRU) and Least Recently used (LRU)	CO3
	Unit 4		
	A	I/O Management Principles of I/O Hardware: I/O devices, Device controllers	CO4

	B	, Direct memory access Principles of I/O Software: Goals of Interrupt handlers , Device drivers , Device	CO4
	C	independent I/O software , Secondary-Storage Structure: Disk structure ,Disk scheduling algorithm	CO4
	Unit 5		
	A	File Management File concept, Aaccess methods, File types, File operation, Directory structure, File System structure, Allocation methods (contiguous,linked, indexed),	CO5
	B	Free-space management (bit vector, linked list, grouping), directory implementation (linear list, hash table),efficiency & performance.	CO5, CO6
	C	Unix/Linux Operating System Development Of Unix/Linux, Role & Function Of Kernel, System Calls, Elementary Linux command & Shell Programming, Directory Structure, System Administration Case study: Linux, Windows Operating System.	CO6
	Mode of examination	Theory	
	Weightage Distribution	CA: 30% / MTE: 20% / ETE: 50%	
	Text book	1. "Operating System Concepts" by Avi Silberschatz and Peter Galvin 2. "Operating Systems: Internals and Design Principles" by William Stallings	
	Other References	3. "Operating Systems: A Concept-Based Approach" by D M Dhamdhere 4. "Operating System: A Design-oriented Approach" by Charles Crowley	

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
C204.1	**3**	**3**	**2**	**2**	**2**	**3**	**2**	**2**	**1**	**2**
C204.2	**2**	**3**	**3**	**3**	**3**	**2**	**1**	**2**	**1**	**2**
C204.3	**2**	**3**	**2**	**2**	**2**	**2**	**2**	**1**	**2**	**2**
C204.4	**2**	**2**	**2**	**3**	**2**	**2**	**2**	**2**	**2**	**2**
C204.5	**3**	**2**	**2**	**3**	**2**	**2**	**2**	**2**	**2**	**2**
C204.6	**2**	**2**	**3**	**2**	**2**	**2**	**3**	**2**	**1**	**1**

DATA WARE HOUSING AND DATA MINING (BDA 205)

School: SBSR		**Batch: 2020- 2023**	
Program: B. Sc. (H)		**Current Academic Year: 2021-22**	
Branch: Data Science		**Semester: III**	
1	Course Code	BDA 205	
2	Course Title	DATA WARE HOUSING AND DATA MINING	
3	Credits	4	
4	Contact Hours (L-T-P)	3-0-1	
	Course Status	Compulsory	
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 about 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 multirelational OLAP, categories of tools, OLAP tools and the internet. (K2, K4) CO4: Explain and illustrate data mining functionalities, interestingness of patterns, integration of a data mining system with a data warehouse issues, data preprocessing . (K2, K3) CO5: Explain the basic concepts of decision tree induction, bayesian classification, rule based classification, classification by back propagation and apply support vector machines, associative classification, lazy learners, other classification methods, prediction. (K2, K3, K4) CO6: Explain and evaluate clustering and trends in data mining. (K2, K4, K6)	
7	Course Description	This course is an introduce 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			
	A	Reporting and Query tools and Applications, Cognos Impromptu, Online Analytical Processing (OLAP).			CO2, CO3
	B	Multidimensional Data Model, OLAP Guideline Multidimensional versus Multirelational OLAP,			CO3
	C	Categories of Tools, OLAP Tools and the Internet.			CO3
	Unit 3	DATA MINING			
	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 a Data Warehouse Issues, Data Preprocessing			CO4
	Unit 4	ASSOCIATION RULE MINING AND CLASSIFICATION			
	A	Mining Frequent Patterns, Associations and Correlations, Mining Methods, Mining various Kinds of Association Rules, Correlation Analysis,			CO5
	B	Constraint Based Association Mining Classification and Prediction, Basic Concepts, Decision Tree Induction, Bayesian Classification, Rule Based Classification, Classification by Back propagation,			CO5
	C	Support Vector Machines, Associative Classification, Lazy Learners, Other Classification Methods, Prediction.			CO5
	Unit 5	CLUSTERING AND TRENDS IN DATA MINING			
	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, Outlier Analysis.			CO6
	C	Data Mining Applications. Apply data mining techniques and methods to large data sets, Use data mining tools, Compare and contrast the various classifiers.			CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Text book/s*	1. Alex Berson and Stephen J.Smith, “Data Warehousing, Data Mining and OLAP”, Tata McGraw – Hill Edition, Thirteenth Reprint 2008. 2. Jiawei Han and Micheline Kamber, “Data Mining Concepts and Techniques”, Third Edition, Elsevier,			

		2012.	
	Other References	1. Pang-Ning Tan, Michael Steinbach and Vipin Kumar, "Introduction to Data Mining", Person Education, 2007. 2. K.P. Soman, Shyam Diwakar and V. Aja, "Insight into Data Mining Theory and Practice", Eastern Economy Edition, Prentice Hall of India, 2006. 3. G. K. Gupta, "Introduction to Data Mining with Case Studies", Eastern Economy Edition, Prentice Hall of India, 2006. 4. Daniel T.Larose, "Data Mining Methods and Models", Wiley-Interscience, 2006.	

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
C205.1	3	3	2	2	2	3	2	2	1	1
C205.2	2	3	3	3	3	2	1	2	1	2
C205.3	2	3	2	2	2	2	2	1	2	2
C205.4	2	3	2	3	2	2	2	2	3	2
C205.5	3	3	2	3	2	1	2	2	2	2
C205.6	3	3	2	2	3	3	2	2	2	2

OOPS USING PYTHON (BDA 211)

School: SBSR	**Batch : 2020- 2023**
Program: B. Sc. (H)	**Current Academic Year: 2021-22**
Branch: Data Science	**Semester: III**

1	Course Code	BDA 211
2	**Course Title**	**OOPS USING PYTHON**
3	Credits	4
4	Contact Hours (L-T-P)	2-0-1
	Course Status	Compulsory
5	Course Objective	To make students familiar with the Python Object Oriented Programming, Python Regular Expression Powerful pattern matching and searching Power of pattern searching using regex in python Real time parsing of networking or system data using regex Password and Python CGI Introduction Writing python program for CGI applications Creating menus and accessing files Server client program.
6	Course Outcomes	CO1: Explain and illustrate the concepts of python object oriented programming. (k2, k3, k4) CO2: Describe python regular expression powerful pattern matching and searching power of pattern searching using regex in python real time parsing of networking or system data using regex password. (K1, K2, K3) CO3: Describe how to do python exception handling avoiding code break. (k2, k3) CO4: Describe Python Database Interaction SQL Database connection using python Creating and searching tables Reading and storing config information on database Programming using database connections. (K2, K3, K4) CO5: Describe the contacting user through emails using python installing smtp python module sending email reading from file and sending emails to all users addressing them directly for marketing. (K2, K3, K6) CO6: Describe Python CGI Introduction Writing python program for CGI applications Creating menus and accessing files Server client program. (K1,K2)
7	Course Description	This course is developing logical Python concept. The primary objective of the course is to develop the basic understanding of the concept of the Python Object Oriented Programming, Python Regular Expression Powerful pattern matching and searching Power of pattern searching using regex in python Real time parsing of networking or system data using regex Password and Python CGI Introduction Writing python program for CGI applications Creating menus and

		accessing files Server client program.	
8	Outline syllabus : OOPS USING PYTHON		CO Mapping
	Unit 1		
	A	Python Object Oriented Programming – Oops Concept of class, object and instances Constructor, class attributes and destructors Real time use of class in live projects Inheritance.	CO1
	B	overlapping and overloading operators Adding and retrieving dynamic attributes of classes Programming using Oops support Python Regular Expression, Powerful pattern matching and searching Power of pattern searching using regex in python	CO1, CO2
	C	Real time parsing of networking or system data using regex Password, email, url validation using regular expression Pattern finding programs using regular expression	CO2
	Unit 2		
	A	Python Exception Handling Avoiding code break using exception handling	CO3
	B	Safe guarding file operation using exception handling Handling.	CO3
	C	Helping developer with error code Programming using Exception handling	CO3
	Unit 3		
	A	Python Database Interaction SQL Database connection using python Creating and searching tables Reading	CO4
	B	storing config information on database Programming using database connections	CO4
	C	Python Multithreading Understanding threads Forking threads Synchronizing the threads Programming using multithreading	CO4
	Unit 4		
	A	Contacting Use r Through Emails Using Python	CO5
	B	Installing smtp python module Sending email Reading	CO5

		from file.			
	C	sending emails to all users addressing them directly for marketing			CO5
	Unit 5				
	A	Python CGI Introduction Writing python program for CGI applications			CO6
	B	Creating menus and accessing files Server client program			CO6
	C	Sample Project			CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Text book/s*	1. Python 3 Object-Oriented Programming - Third Edition by Dusty Phillips.			
	Other References	1. Mastering Object-Oriented Python: Build powerful applications with reusable code using OOP design patterns and Python 3.7 By Steven F. Lott			

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
C211.1	**2**	**2**	**2**	**3**	**2**	**2**	**2**	**3**	**2**	**1**
C211.2	**2**	**2**	**3**	**3**	**2**	**2**	**2**	**2**	**1**	**2**
C211.3	**2**	**2**	**2**	**2**	**3**	**2**	**1**	**2**	**2**	**2**
C211.4	**2**	**2**	**2**	**3**	**2**	**2**	**2**	**2**	**2**	**2**
C211.5	**3**	**2**	**3**	**3**	**2**	**1**	**2**	**1**	**2**	**1**
C211.6	**3**	**2**	**2**	**2**	**2**	**2**	**2**	**1**	**2**	**2**

Community Connect (CCU 401)

<table>
<tr><td colspan="2">SCHOOL: School of Basic Sciences and Research</td><td>TEACHING DEPARTMENT: Community Connect</td><td>ACADEMIC SESSION : 2018-19</td><td>FOR STUDENTS BATCH – B. Sc and M. Sc.(2017-18 & 2018-19)</td></tr>
<tr><td>1</td><td>Course Number</td><td colspan="3">Course Code: CCU401/ Course ID: 30804</td></tr>
<tr><td>2</td><td>Course Title</td><td colspan="3">Community Connect</td></tr>
<tr><td>3</td><td>Credits</td><td colspan="3">2</td></tr>
<tr><td>3.01</td><td>(L-T-P)</td><td colspan="3">(00-00-02)</td></tr>
<tr><td>4</td><td>Learning Hours</td><td colspan="3"><table><tr><td>Contact Hours</td><td>30</td></tr><tr><td>Project/Field Work</td><td>20</td></tr><tr><td>Assessment</td><td>00</td></tr><tr><td>Guided Study</td><td>10</td></tr><tr><td>Total hours</td><td>60</td></tr></table></td></tr>
<tr><td>5</td><td>Course Objectives</td><td colspan="3">1. To expose our students to different social issues faced by the people in different sections of society.
2. To connect their class-room learning with problem solving skills in real life scenario.</td></tr>
<tr><td>6</td><td>Course Outcomes</td><td colspan="3">After completion of this course students will be able to:
1. Recognise social problems prevailing in different sections of society and finding the solution in sustainable manner.
2. Get practical exposure of all round development which complements their class room learning
3. These activities will add value to students, faculty members, school and university.</td></tr>
<tr><td>7</td><td>Theme</td><td colspan="3">Major themes for research:

1. Survey and self-learning: In this mode, students will make survey, analyze data and will extract results out of it to correlate with their theoretical knowledge. E.g. Crops and animals, land holding, labour problems, medical problems of animals and humans, savage and sanitation situation, waste management etc.
2. Survey and solution providing: In this mode, students will identify the common problems and will provide solution/ educate rural population. E.g. air and water pollution, need of after treatment, use of renewable (mainly solar) energy, electricity saving devices, inefficiencies in cropping system, animal husbandry, poultry, pest control, irrigation, machining in agriculture etc.
3. Survey and reporting: In this mode students will educate villagers and survey the ground level status of various government schemes meant for rural development. The analyzed results will be reported to concerned agencies which will help them for taking necessary/corrective measures. E.g. Pradhan Mantri Jan Dhan Yojana,</td></tr>
</table>

		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.
8.1	**<u>Guidelines for Faculty Members</u>**	It will be a group assignment. There should be not more than 10 students in each group. The faculty guide will guide the students and approve the project title and help the student in preparing the questionnaire and final report. The questionnaire should be well design and it should carry at least 20 questions (Including demographic questions). The faculty will guide the student to prepare the PPT. The topic of the research should be related to social, economical or environmental issues concerning the common man. The report should contain 2,500 to 3,000 words and relevant charts, tables and photographs. The student should**submit the report**to CCC-Coordinator signed by the faculty guide by 15 April 2019. The students have to send the hard copy of the **report and PPT**, and then only they will be allowed for ETE.
8.2	**Role of CCC-Coordinator**	The CCC Coordinator will supervise the whole process and assign students to faculty members. 1. PG-M.Sc.-Semester II – the students will be allocated to faculty member (mentors/faculty member) in even term. 2. UG- B.Sc.-Semester III - the students will be allocated to faculty member (mentors/faculty member) in odd term.
8.3	**Layout of the Report**	Abstract(250 words) a. Introduction b. Literature review(optional) c. Objective of the research d. Research Methodology e. Finding and discussion f. Conclusion and recommendation g. References Note: Research report should base on primary data.

8.4	**Guideline for Report Writing**	**Title Page: The following elements must be included:** • Title of the article; • Name(s) and initial(s) of author(s), preferably with first names spelled out; • Affiliation(s) of author(s); • Name of the faculty guide and Co-guide **Abstract:** Each article is to be preceded by a succinct abstract, of up to 250 words, that highlights the objectives, methods, results, and conclusions of the paper. **Text:Manuscripts should be submitted in Word.** • Use a normal, plain font (e.g., 12-point Times Roman) for text. • Use italics for emphasis. • *Use the automatic page numbering function to number the pages.* • *Save your file in docx format* (Word 2007 or higher) or doc format (older Word versions) **Reference list:** The list of references should only include works that are cited in the text and that have been published or accepted for publication. The entries in the list should be in alphabetical order. Journal article Hamburger, C.: Quasimonotonicity, regularity and duality for nonlinear systems of partial differential equations. Ann. Mat. Pura Appl. 169, 321–354 (1995) Article by DOI Sajti, C.L., Georgio, S., Khodorkovsky, V., Marine, W.: New nanohybrid materials for biophotonics. Appl. Phys. A (2007). doi:10.1007/s00339-007-4137-z Book Geddes, K.O., Czapor, S.R., Labahn, G.: Algorithms for Computer Algebra. Kluwer, Boston (1992) Book chapter Broy, M.: Software engineering — from auxiliary to key technologies. In: Broy, M., Denert, E. (eds.) Software Pioneers, pp. 10–13. Springer, Heidelberg (2002) Online document Cartwright, J.: Big stars have weather too. IOP Publishing PhysicsWeb. http://physicsweb.org/articles/news/11/6/16/1 (2007). Accessed 26 June 2007 Always use the standard abbreviation of a journal's name according to the ISSN List of Title Word Abbreviations, see www.issn.org/2-22661-LTWA-online.php For authors using EndNote, Springer provides an output style that supports the formatting of in-text citations and reference list. EndNote style (zip, 2 kB) **Tables:All tables are to be numbered using Arabic numerals.** **Figure Numbering:All figures are to be numbered using Arabic numerals**. The soft copy of final report should be submitted by email to Dr. Piali Haldar(piali.haldar@sharda.ac.in)within 16th **April2019 along with hard copy signed by faculty guide.**
8.5	**Format:**	**The report should be Spiral/ hardbound** The Design of the Cover page to report will be given by the Coordinator- CCC Coverpage Acknowledgement Content

		Project report Appendices

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
C401.1	-	-	1	1	1	-	2	1	-	2
C401.2	-	-	2	1	1	-	2	2	-	2
C401.3	-	-	1	1	2	-	2	1	-	2

Program: B.Sc. (H)		Current Academic Year: 2021-22	
Branch: Data Science		**Semester: IV**	
1	Course Code	BDA 203	
2	Course Title	**Text Analytics**	
3	Credits	4	
4	Contact Hours (L-T-P)	3-0-1	
	Course Status	Compulsory	
5	Course Objective	This course is aimed to provide an introduction to the natural language, linguistics, text analytics, processing and understanding text, text classification, classification algorithms, text summarization.	
6	Course Outcomes	CO1: Explain and illustrate natural language, linguistics, language syntax and structure, language semantics, text corpora, natural language processing, text analytics. (K3, K4) CO2: Discuss about the text tokenization, text normalization. (K3,K4) CO 3: Develop the understanding of text syntax and structure. (K5, K6) CO 4: Explain and illustrate automated text classification, text classification blueprint, text normalization, feature extraction, bag of words model, advanced word vectorization models. (K3, K6) CO 5: Demonstrate the understanding of multinomial naïve bayes, support vector machines, evaluating classification models, building a multi-class classification system, applications and uses.(K2, K5) CO 6: Recognize and assess the applications of text summarization and information extraction, text normalization, feature extraction, keyphrase extraction, topic modeling: latent semantic. (K1, K6)	
7	Course Description	This course is an introduce the natural language, linguistics, text analytics, processing and understanding text, text classification, classification algorithms, text summarization.	
8	Outline syllabus		CO Mapping
	Unit 1		
	A	Natural Language, Linguistics, Language Syntax and Structure.	CO1
	B	Language Semantics, Text Corpora.	CO1
	C	Natural Language Processing, Text Analytics.	CO1
	Unit 2		
	A	Processing and Understanding Text: Text Tokenization,	CO2
	B	Text Normalization,	CO3
	C	Understanding Text Syntax and Structure.	CO4
	Unit 3		
	A	Text Classification: What Is Text Classification, Automated Text Classification.	CO4
	B	Text Classification Blueprint, Text Normalization, Feature Extraction.	CO4

	C	Bag of Words Model, Advanced Word Vectorization Models.			CO4
	Unit 4				
	A	Classification Algorithms: Multinomial Naïve Bayes, Support Vector Machines,			CO5
	B	Evaluating Classification Models,			CO5
	C	Building a Multi-Class Classification System, Applications and Uses.			CO5
	Unit 5				
	A	Text Summarization: Text Summarization and Information Extraction, Text Normalization, Feature Extraction, Keyphrase Extraction.			CO6
	B	Topic Modeling: Latent Semantic Indexing, Latent Dirichlet Allocation, Non-negative Matrix			CO6
	C	Factorization, Extracting Topics from Product Reviews. Automated Document Summarization.			CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Text book/s*	Applied Text Analysis with Python: Enabling Language-Aware Data Products with Machine Learning 1st Edition by Benjamin Bengfor			
	Other References	Applied Text Analysis with Python by Benjamin Bengfort, Rebecca Bilbro, Tony Ojeda			

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
C203.1	**3**	**3**	**2**	**2**	**2**	**3**	**2**	**2**	**1**	**2**
C203.2	**2**	**3**	**3**	**3**	**3**	**2**	**1**	**2**	**2**	**2**
C203.3	**2**	**3**	**2**	**2**	**3**	**2**	**2**	**1**	**2**	**2**
C203.4	**2**	**2**	**2**	**3**	**2**	**2**	**1**	**2**	**2**	**2**
C203.5	**3**	**2**	**2**	**3**	**3**	**1**	**2**	**2**	**2**	**2**

C203.6	**3**	**3**	**2**	**2**	**3**	**3**	**2**	**2**	**2**	**2**

REGRESSION, TIME SERIES, FORECASTING AND INDEX NUMBERS
(BDA 206)

School: SBSR		**Batch : 2020- 2023**	
Program: B.Sc. (H)		**Current Academic Year: 2021-22**	
Branch: Data Science		**Semester: IV**	
1	Course Code	BDA 206	
2	Course Title	Regression, time series, forecasting and Index numbers	
3	Credits	4	
4	Contact Hours (L-T-P)	3-1-0	
	Course Status	Compulsory	
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, regression models for general time series data. (K6) CO3: Explain and illustrate first-order exponential smoothing, modeling time series data, second-order exponential smoothing, higher-order exponential smoothing. (K3, K6) CO4: Use forecasting: constant process, linear trend process and evaluate estimation of σ_e^2, adaptive updating of the discount factor, model assessment. (K3, K6) CO5: Describe autoregressive integrated moving average (arima) models. (K2) CO6: Explain and illustrate index numbers with 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	, Statistical Inference in Linear Regression, Prediction of New Observations, Model Adequacy Checking			CO2
	C	, Model Adequacy Checking, Generalized and Weighted Least Squares, Regression Models for General Time Series Data.			CO2
	Unit 3				
	A	Exponential Smoothing Methods: First-Order Exponential Smoothing, Modeling Time Series Data			CO3
	B	, Second-Order Exponential Smoothing, Higher-Order Exponential Smoothing,			CO4
	C	Forecasting: Constant Process, Linear Trend Process, Estimation of σ_e^2, Adaptive Updating of the Discount Factor, Model Assessment.			CO4
	Unit 4				
	A	Autoregressive Integrated Moving Average (ARIMA) Models : Linear Models for Stationary Time Series, Stationary Time Series, 3 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,1 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	MTE	ETE	
		30%	20%	50%	

	Text book/s*	1. Business Statistics: For Contemporary Decision Making, 7th Edition by Ken Black	
	Other References	1. Daniel,WayneW.,"Biostatistics": Basic concept and Methodology for Health Science. 2. Grewal,B.S, "Higher Engineering Mathematics".	

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
C206.1	3	3	2	2	2	3	2	2	2	2
C206.2	2	3	3	3	3	2	1	2	2	2
C206.3	2	3	2	2	2	2	2	2	2	2
C206.4	2	2	2	3	2	2	1	2	2	2
C206.5	3	2	2	3	2	2	2	2	2	3
C206.6	2	3	2	2	2	2	1	2	2	2

MULTIVARIATE ANALYSIS (BDA 207)

School: SBSR	**Batch: 2020- 2023**
Program: B. Sc. (H)	**Current Academic Year: 2021-22**

Branch: Data Science		Semester: IV
1	Course Code.	BDA 207
2	Course Title	**Multivariate Analysis**
3	Credits	4
4	Contact Hours (L-T-P)	3-0-1
	Course status	Compulsory
5	Course Objectives	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 the concept of estimation of the mean vector and the covariance matrix. (K2, K3) CO3: Demonstrate advanced understanding of the concepts of The Distributions and Uses of Sample Correlation Coefficients. (K2, K3) CO4: Describe and apply conditional distributions, the multiple correlation coefficients. (K2, K3) CO5: Apply the basic tools of statistics and explain classification of observations. (K3, K4, K5) CO6: Understand and evaluate the distribution of the sample covariance matrix and the sample generalized variance. (K2, K6)
7	Course Description	The aim of this module is 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:	
UNIT 1		CO Mapping
A	The Multivariate Normal Distribution: Notions of Multivariate Distributions,	CO1
B	The Multivariate Normal Distribution, The Distribution of Linear Combinations of Normally: Distributed Variates; independence of Variates; Marginal Distributions,	CO1
C	Conditional Distributions and Multiple Correlation Coefficient, The Characteristic Function; Moments, Elliptically Contoured Distributions.	CO1

UNIT 2				
A	Estimation of the Mean Vector and the Covariance Matrix: The Maximum Likelihood Estimators of the Mean Vector and the Covariance Matrix,			CO2
B	The Distribution of the Sample Mean Vector; Inference Concerning the Mean When the Covariance Matrix Is Known,			CO2
C	Theoretical Properties of Estimators of the Mean Vector, Improved Estimation of the Mean.			CO2
UNIT 3				
A	The Distributions and Uses of Sample Correlation Coefficients: Correlation Coefficient of a Bivariate Sample,			CO3
B	Partial Correlation Coefficients			CO3, CO4
C	Conditional Distributions, The Multiple Correlation Coefficients.			CO4
UNIT 4				
A	Classification of Observations: The Problem of Classification, Standards of Good Classification, Procedures of Classification into One of Two Populations with Known Probability Distributions,			CO5
B	Classification into One of Two Known Multivariate Normal Populations, Classification into One of Two Multivariate Normal Populations When the Parameters Are Estimated, Probabilities of Misclassification.			CO5
C	Classification into One of Several Populations, Classification into One of Several Multivanate Normal Populations, An Example of Classification into One of Several Multivanate Normal Populations.			CO5
UNIT 5				
A	The Distribution of the Sample Covariance Matrix and the Sample Generalized Variance: The Wishart Distribution, Some Properties of the Wishart Distribution, Cochran's Theorem, The Generalized Variance,.			CO6
B	Distribution of the Set of Correlation Coefficients When the Population Covariance Matrix Is Diagonal, The Inverted Wishart Distribution			CO6
C	Bayes Estimation of the Covariance Matrix, Improved Estimation of the Covariance Matrix.			CO6
	Mode of Examination	Theory		
	Weightage distribution	CA	MTE	ETE
		30%	20%	50%

	Text books	1. Johnson, R.A. and Wichern, D.W.: (2015). Applied Multivariate Statistical Analysis, Sixth Edition, Pearson Education India. 2. Hardle, W.K. and Hlavka, Z. (2015): Multivariate Statistics, Springer.
	Other references	1. Anderson, T.W. (2003): An Introduction to Multivariate Statistical Analysis, Third Edition, Wiley. 2. Härdle, W.K. and Simar, L. (2015): Applied Multivariate Statistical Analysis, Springer.

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
C207.1	3	3	2	2	2	3	2	2	1	2
C207.2	2	3	3	3	3	2	1	2	2	2
C207.3	2	3	2	3	2	2	2	1	2	3
C207.4	2	3	2	3	2	2	2	2	3	2
C207.5	3	3	2	3	2	1	2	2	2	2
C207.6	3	3	2	2	3	3	2	2	2	2

School: SBSR		Batch: 2020- 2023	
Program: B.Sc. (H)		Current Academic Year: 2021-22	
Branch: Data Science		Semester: IV	
1	Course Code	BDA 208	
2	Course Title	**STATISTICAL INFERENCE (NON- PARAMETRIC)**	
3	Credits	4	
4	Contact Hours (L-T-P)	3-0-1	
	Course Status	Compulsory	
5	Course Objective	Familiarise students with basic concepts of order statistics, nonparametric estimation, interval estimation and tolerance limits, permutation tests, ordered least squares estimators.	
6	Course Outcomes	CO1: Explain the concept of order statistics and large sample properties of sample quintiles. (K2, K4) CO2: Apply the concept of nonparametric estimation and explain completeness of the order statistic. (K3) CO3: Explain and use ordered least squares estimators. (K2, K3, K4) CO4: Explain optimum properties of ordered least squares estimates.(K2, K4) CO5: Describe the interval estimation and tolerance limits. (K1, K2) CO6: Understand and evaluate permutation tests and modified permutation tests. (K2, K6)	
7	Course Description	This course will cover the basic concepts of order statistics, nonparametric estimation, interval estimation and tolerance limits, permutation tests, ordered least squares estimators.	
8	Outline syllabus		CO Mapping
	Unit 1		
	A	Order Statistics: Domain of Nonparametric Statistics, Order Statistics, Distribution Theory of Order Statistics, Distribution of Sample Range and Mid Range,	CO1
	B	The Distribution of the Median, Sampling Distribution of the Coverages, Moments of Order Statistics, Order Statistics for Discrete Populations, Representation of Exponential Order Statistics as a Sum of Independent Random Variables,	CO1
	C	Representation of General Order Statistics, Angel and Demons' Problems, Large Sample Properties of Order Statistics, Large Sample Properties of Sample Quintiles.	CO1
	Unit 2		
	A	Nonparametric Estimation: Problems in Non-parametric Estimation, One-sided Confidence Interval for p,	CO2
	B	Two-sided Confidence Interval for p, Estimation of Distribution Function,	CO2

	C	Characterization of Distribution-free Statistics, Completeness of the Order Statistic.	CO2
	Unit 3		
	A	Ordered Least Squares Estimators: Explicit Formulae for Estimators,	CO3
	B	Estimation for Symmetric Populations, Estimation in a Single Parameter Family,	CO3, CO4
	C	Optimum Properties of Ordered Least Squares Estimates.	CO4
	Unit 4		
	A	Interval Estimation and Tolerance Limits: Confidence Intervals for Quantiles,	CO5
	B	Large Sample Confidence Intervals: Wilks' (1962) Method, Tolerance Limits,	CO5
	C	Distribution-free Tolerance Limits, Other Tolerance Limit Problems, Tolerance Regions .	CO5
	Unit 5		
	A	Permutation Tests: Bivariate Independence, Two-sample Problems, Critical Regions Having Structures,	CO6
	B	Most Powerful Permutation Tests, One-sample Problems, Tests in Randomized Blocks,	CO6
	C	Large-sample Power, Modified Permutation Tests.	CO6
	Mode of examination	Theory	
	Weightage Distribution	CA: 30% / MTE: 20% / ETE: 50%	
	Text books	1. Gibbons, J.D. & Chakraborti, S. (2010). Nonparametric Statistical Inference, 5th Edition. CRC Press. 2. Hollander, M., Wolfe, D. & Chicken, E. (2013). Nonparametric Statistical Methods, 3rd Edition. Wiley.	
	Other references	1. Bonnini, S., Corain, L., Marozzi, M. & Salmaso, L. (2014). 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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
C208.1	3	3	2	2	2	3	2	2	1	1
C208.2	2	3	3	3	3	2	1	2	2	2
C208.3	2	3	2	1	2	2	2	1	2	2
C208.4	2	2	2	3	2	2	1	2	2	2
C208.5	3	2	2	3	2	2	2	2	2	1
C208.6	3	3	2	2	3	3	2	2	2	2

School: SBSR		**Batch: 2020- 2023**	
Program: B.Sc. (H)		**Current Academic Year: 2021-22**	
Branch: Mathematics		**Semester: IV**	
1	Course Code	BDA 209	
2	Course Title	**RECOMMENDER SYSTEMS**	
3	Credits	4	
4	Contact Hours (L-T-P)	3-0-1	
	Course Status	Compulsory	
5	Course Objective	Familiarise students with basic concepts of recommender system functions, collaborative filtering, content-based recommendation, knowledge based recommendation, hybrid approaches. Discuss the concept of evaluating recommender system and recommender systems and communities.	
6	Course Outcomes	CO1: Explain the concept of recommender system functions, linear algebra notation. (K2, K4) CO2: Discuss the concept of collaborative filtering (K3) CO3: Explain the use of content-based recommendation, classification algorithms. (K2, K3, K4) CO4: Explain the knowledge based recommendation, hybrid approaches. (K2, K4,K5) CO5: Describe the evaluating recommender system. (K1, K2, K4) CO6: Understand and evaluate recommender systems and communities. (K2, K6)	
7	Course Description	This course will cover the basic concepts of recommender system functions, collaborative filtering, content-based recommendation, knowledge based recommendation, hybrid approaches. Discuss the concept of evaluating recommender system and recommender systems and communities.	
8	Outline syllabus		CO Mapping
	Unit 1		
	A	**Introduction:** Recommender system functions, Linear Algebra notation: Matrix addition, Multiplication, transposition, and inverses; covariance matrices, Understanding ratings, Applications of recommendation systems, Issues with recommender system.	CO1, CO2
	B	**Collaborative Filtering:** User-based nearest neighbor recommendation, Item-based nearest neighbor recommendation.	CO1, CO2
	C	Model based and pre-processing based approaches,	CO1, CO2

		Attacks on collaborative recommender systems.			
	Unit 2				
	A	**Content-based recommendation:** High level architecture of content-based systems, Advantages and drawbacks of content based filtering,			CO3
	B	Item profiles, Discovering features of documents, Obtaining item features from tags,			CO3
	C	Representing item profiles, Methods for learning user profiles, Similarity based retrieval, Classification algorithms.			CO3
	Unit 3				
	A	**Knowledge based recommendation**: Knowledge representation and reasoning, Constraint based recommenders, Case based recommenders.			CO4
	B	**Hybrid approaches**: Opportunities for hybridization, Monolithic hybridization design: Feature combination, Feature augmentation,			CO4
	C	Parallelized hybridization design: Weighted, Switching, Mixed, Pipelined hybridization design: Cascade Meta-level, Limitations of hybridization strategies.			CO4
	Unit 4				
	A	**Evaluating Recommender System:** Introduction, General properties of evaluation research.			CO5
	B	Evaluation designs, Evaluation on historical datasets, Error metrics.			CO5
	C	Decision-Support metrics, User-Centred metrics.			CO5
	Unit 5				
	A	**Recommender Systems and communities**: Communities, collaboration and recommender systems in personalized web search.			CO6
	B	Social tagging recommender systems, Trust and recommendations, Group recommender systems.			CO6
	C	**Laboratory Work:** To implement algorithms and techniques given above using relevant tools or high level language. To design recommendation system for a particular application domain.			CO6
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Text books	1. Recommender Systems by Charu C. Aggarwal			

	Other references		

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
C209.1	3	3	2	2	2	3	2	2	1	1
C306.2	2	3	3	3	3	2	1	2	2	2
C306.3	2	3	2	1	2	2	2	1	2	2
C306.4	2	2	2	3	2	2	1	2	2	2
C306.5	3	2	2	3	2	2	2	2	2	1
C306.6	3	3	2	2	3	3	2	2	2	2

DATA VISUALIZATION (BDA 210)

School: SBSR		Batch: 2020- 2023
Program: B.Sc. (H)		Current Academic Year: 2021-22
Branch: Data Science		Semester: IV
1	Course Code	BDA 210
2	Course Title	DATA VISUALIZATION
3	Credits	4
4	Contact Hours (L-T-P)	3-0-1
	Course Status	Compulsory
5	Course Objective	Familiarise students with basic concepts of data visualization. Give an idea of data-analytic thinking, storytelling with data, data visualization using tableau 1. Given an understanding of a decision analytic thinking, fitting a model to data. Discuss the concept of visualizing model performance, data

		visualization using tableau 2, similarity, neighbors, and clusters.	
6	Course Outcomes	CO1: Explain the concept of data-analytic thinking. (K2, K4) CO2: Discuss the concept of data understanding; data preparation; modelling; evaluation; deployment. Analytic techniques and technologies. (K3) CO3: Explain the use of storytelling with data and support vector machines, decision trees.(K2, K3, K4) CO4: Explain the data visualization using tableau 1 and decision analytic thinking. (K2, K4,K5) CO5: Describe the fitting a model to data and visualizing model performance. (K1, K2, K4) CO6: Explain and evaluate data visualization using tableau 2 and similarity, neighbors, and clusters. (K2, K6)	
7	Course Description	This course will cover the basic concepts of data visualization. Give an idea of data-analytic thinking, storytelling with data, data visualization using tableau 1. Given an understanding of a decision analytic thinking, fitting a model to data. Discuss the concept of visualizing model performance, data visualization using tableau 2, similarity, neighbors, and clusters	
8	Outline syllabus		CO Mapping
	Unit 1		
	A	**Data-Analytic Thinking**: The Ubiquity of Data Opportunities,*f* Data Processing and "Big Data" *f* From Big Data 1.0 to Big Data 2.0,	CO1, CO2
	B	Data and Data Science Capability as a Strategic Asset. From Business Problems to Data Mining Tasks: Business Understanding;	CO1, CO2
	C	Data Understanding; Data Preparation; Modeling; Evaluation; Deployment. Analytic techniques and technologies.	CO1, CO2
	Unit 2		
	A	**Story Telling with Data**: Importance of context ; Choosing an effective visual ; Focus audience's attention ;Thinking like designer ;	CO3
	B	Dissecting model visuals ;Lessons in story telling ;Putting it all together ; Case studies. Introduction to	CO3
	C	Predictive Modeling: Linear Regression; *f*Classification: Logistic, Regression, Support Vector Machines, Decision Trees.	CO3
	Unit 3		
	A	**Data Visualization Using Tableau 1**: *f* Introduction to Tableau; Data Import and Management: Data import, Extract and live , Data management – Join, Data management – Relationship, Data Management –	CO4

		Replace; Data Type and Operation: Data type, Pivot and separate , Change type, Set and group, Hierarchy.	
	B	**Decision Analytic Thinking**: Targeting the Best Prospects for a Charity Mailing -The Expected Value Framework: Decomposing the Business Problem and Recomposing the Solution Pieces , A Brief Digression on Selection Bias;	CO4
	C	Churn Example Revisited with Even More Sophistication - The Expected Value Framework: Structuring a More Complicated Business Problem , Assessing the Influence of the Incentive; From an Expected Value Decomposition to a Data Science Solution.	CO4
	Unit 4		
	A	**Fitting a Model to Data:** What is a good model? - Overfitting , Generalization *f* Evaluating Classifiers , Plain Accuracy and Its Problems , Confusion Matrix , Problems with Unbalanced Classes, Problems with Unequal Costs and Benefits ;	CO5
	B	*f* Generalizing Beyond Classification - Using Expected Value to Frame Classifier Evaluation; *f* Evaluation, Baseline Performance, and Implications for Investments in Data.	CO5
	C	**Visualizing Model Performance**: *f* Ranking Instead of Classifying; Profit Curves; ROC Graphs and Curves; The Area Under the ROC Curve (AUC); Cumulative Response and Lift Curves; Example: Performance Analytics for Churn Modeling.	CO5
	Unit 5		
	A	**Data Visualization Using Tableau 2**: *f* Different types of data visualizations - Visual encoding , Bar chart and pie chart , Line chart ,Multiple chart and distribution , Highlight tables , Scatter plot and trend lines, Heatmap , Geographic mapping ,Bullet graph , Gnatt chart , Data calendar , Circle view.	CO6
	B	**Similarity, Neighbors, and Clusters** : Similarity and Distance; Nearest-Neighbor Reasoning o Example: Whiskey Analytics , How Many Neighbors and How Much Influence? , Issues with Nearest-Neighbor Methods;	CO6
	C	Clustering - Hierarchical clustering *f* Example: Whiskey Analytics, Nearest Neighbors Revisited: Clustering Around Centroids; *f* Example: Clustering Business News Stories -Understanding the Results of Clustering; Stepping Back: Solving a Business Problem	CO6

		Versus Data Exploration.			
	Mode of examination	Theory			
	Weightage Distribution	CA	MTE	ETE	
		30%	20%	50%	
	Text books	1) Information Dashboard Design: Displaying Data for At-a-glance Monitoring" by Stephen Few 2) Beautiful Visualization, Looking at Data Through the Eyes of Experts by Julie Steele, Noah Iliinsky			
	Other references	1. The Accidental Analyst: Show Your Data Who's Boss" by Eileen and Stephen McDaniel			

COURSE OUTCOMES – PROGRAMME OUTCOMES MAPPING TABLE

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
C306.1	3	3	2	2	2	3	2	2	2	2
C306.2	2	3	3	3	3	2	1	2	2	2
C306.3	2	3	2	1	2	2	2	2	2	2
C306.4	2	2	2	3	2	2	1	2	2	2
C306.5	3	2	2	3	2	2	2	2	2	2
C306.6	3	3	2	2	3	3	2	2	2	2