MANIPAL
ACADEMY of HIGHER EDUCATION
(Deemed to be University under Section 3 of the UGC Act, 1956)

Department of Data Science

Prasanna School of Public Health

Manipal Academy of Higher Education, Manipal

Learning Outcomes-based Curriculum Framework (LOCF)

Two Year full time Postgraduate Programme

M.Sc. (Data Science)

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1. NATURE AND EXTENT OF THE PROGRAMME

The two-year M.Sc. (Data Science) programme offered is a perfect blend of machine learning, big data analytics, statistics, computational and biological sciences. Courses include linear algebra, matrix theory, probability distributions, statistical inference, machine learning, simulation, data management, data warehousing, deep learning, text mining and programming with R, Python, Hadoop, Spark and SAS. Regular classes are conducted for the first three semesters and the last semester is exclusively devoted to internship in either a corporate or an academic institution of repute.

Graduates with the following qualifications (with a minimum of 60% of marks or an equivalent grade) from UGC recognized universities/institutions are eligible to apply for M.Sc. (Data Science) programme.

- BSc. Statistics/Mathematics/Computer Science
- BE/B. Tech
- BCA
- Any other Graduation with a minimum of two years of learning of Mathematics or Statistics

Programming knowledge is a pre-requisite for admissions to this programme.

Selection of eligible candidates will be based on merit of rank obtained in the entrance examination and/or personal interview. In the absence of entrance examination/interview, the merit of rank is prepared by using the grade obtained in Mathematics and/or Statistics and/or Computer Science in the qualifying examinations.

The department prepares students for a career as data scientists and researchers enabling them to make a mark in the corporate sector as well as academic institutions. Through industry-academia collaborations, the department provides placement assistance to the students on successful completion of the course.

2. PROGRAMME EDUCATION OBJECTIVEs (PEO)

The M.Sc. (Data Science) programme is devoted to the specialized training in analytical skills as applied to computational and biological sciences. It aims to nurture the recipients develop as statistical programmers with productive careers in corporate sector through

- Strong methodological foundations in analytics
- Versatile training in handling statistical consultations
- Competency in the use of appropriate techniques, skills and tools necessary for data science

The overall objectives of the Learning Outcomes-based Curriculum Framework (LOCF) for **M.Sc. (Data Science)** programme are as follows.

PEO #	Education Objective
PEO 1	Students will be able to effectively visualize and describe data through appropriate statistical methods.
PEO 2	Students will be proficient to identify and apply the most appropriate analytical methods or techniques to solve real world problems.
PEO 3	Students will be able to demonstrate programming skills to provide data driven solutions for decision making.
PEO 4	Students will be able to project their teamwork capabilities through statistical consultations for research projects by best practices of collation and dissemination of data at hand.
PEO 5	Students will be able to exhibit their leadership and pedagogy skills.
PEO 6	Students will be competent to pursue higher studies.

3. GRADUATE ATTRIBUTES

Sl #	Attribute	Description
1	**Disciplinary knowledge**	Adequate competency in the domains of data science such as data mining, machine learning, predictive modelling, visualization techniques, statistics and their application.
2	**Measurable skills and industry-ready professionals**	Competency in the use/development of appropriate techniques, skills and tools to provide data driven solutions to real world problems. Capability to use various communication technologies (both online and offline).
3	**Communication and teamwork**	Effective and influencing oral/written communication ability to share thoughts, ideas and findings. Ability to work in a team as well as in isolation.
4	**Leadership readiness/qualities**	Capability to map tasks of a team or an organization, formulate an inspiring vision, build a team to achieve desired objectives, motivate and inspire team members. Cultivate key characteristics in learners, to be visionary leaders who can inspire the team to greatness.
5	**Problem solving**	Capacity to extend the knowledge and competencies gained through the programme to solve novel or non-familiar real-world problems.
6	**Analytical reasoning / Critical thinking**	Ability to employ critical and reflective thinking to gain expertise required to analyse data and improve decision making.
7	**Self-directed learning**	Ability to work independently, identify appropriate resources required and solve real world problems.
8	**Ethical awareness**	Understand the importance of data integrity, data confidentiality, data security and abide by professional ethics.
9	**Lifelong learning**	Foster independent, coherent and decisive thoughts to ultimately develop competency and motivate lifelong learning.
10	**Research-related skills**	Develop originality in thoughts that will enable the student to formulate novel and creative methodologies to tackle real-life multi-disciplinary problems.

4. QUALIFICATION DESCRIPTORS

The qualification descriptors for the master's degree will

- Demonstrate (i) a systematic knowledge of Data Science and its applications to emerging real world problems, (ii) skills in the areas related to current developments in applications of Data Science, (iii) procedural knowledge that creates Data Science professionals in the government and public services.
- Exhibit skills in retrieval of quantitative and/or qualitative data, analysis and interpretation of data using appropriate methodologies.
- Use knowledge, understanding and skills for critical assessment of a wide range of ideas and complex problems related to Data Science.
- Foster the ability to effectively communicate the data-driven solutions in a clear and concise manner to stakeholders across a broad range of disciplines.
- Address one's learning needs relating to current and emerging areas of study, making use of professional materials as appropriate, including those related to new frontiers of knowledge.
- Showcase subject-specific and transferable skills that will provide a competitive edge in career opportunities.
- Develop skills that are pre requisite for higher studies.

5. PROGRAMME OUTCOMES

On successful completion of M.Sc. (Data Science), students will be able to:

PO #	Attribute	Competency
PO 1	**Disciplinary knowledge**	Illustrate in-depth knowledge of data management, analysis and problem solving.
PO 2	**Measurable skills and industry-ready professionals**	Exercise professional skills and values to accept challenges in the industry and academia.
PO 3	**Communication and teamwork**	Demonstrate team work, decision making skills and effective communication of study design/findings.
PO 4	**Leadership readiness/qualities**	Identify and appraise the leadership skills required to direct a team of data science professionals towards meeting organizational goals.
PO 5	**Problem solving**	Apply data science skills to real world problems and effectively present the results.
PO 6	**Analytical reasoning / Critical thinking**	Employ analytical and critical thinking to develop methods to provide solutions based on global needs and trends.
PO 7	**Self-directed learning**	Formulate learning goals, identify resources and implement appropriate learning tools for innovative problem-solving.
PO 8	**Ethical awareness**	Practice the ethics of data science.
PO 9	**Lifelong learning**	Develop and strengthen conceptual knowledge; recognize the need for self-motivation to engage in lifelong learning.
PO 10	**Research-related skills**	Acquire and apply research based knowledge; enhance proficiency through exploration of current research in data science and develop novel methodologies to solve complex problems.

6. COURSE STRUCTURE, COURSE-WISE LEARNING OUTCOMES AND COURSE OUTCOMES

FIRST YEAR

Block: 1

Course Code	Course Title	L	T	P	C
DDS 511	Computational Mathematics	5	-	5	3
DDS 512	Probability and Probability Distributions	5	-	5	3
DDS 513	Programming with R and Python	-	-	10	2
Total		**10**	**-**	**20**	**8**

Block: 2

Course Code	Course Title	L	T	P	C
DDS 521	Statistical Inference	8	-	6	4
DDS 522	Data Processing, Data Management and Data Warehousing	-	-	15	3
Total		**8**	**-**	**21**	**7**

Block: 3

Course Code	Course Title	L	T	P	C
DDS 531	Linear Regression Models	3	-	5	2
DDS 532	Categorical Data Analysis and Generalized Linear Models	5	-	5	3
DDS 533	Distributed Algorithms and Optimization with Hadoop and Spark	3	-	10	3
Total		**11**	**-**	**20**	**8**

Block: 4

Course Code	Course Title	L	T	P	C
DDS 541	Stochastic Processes	5	-	5	3
DDS 542	Design and Analysis of Experiments	5	-	5	3
DDS 543	Longitudinal Data Analysis	5	-	5	3
Total		**15**	**-**	**15**	**9**

Block: 5

Course Code	Course Title	L	T	P	C
DDS 551	Statistical Methods for Machine Learning	8	-	6	4
DDS 552.1	Non-parametric and Non-linear Regression Models	5	-	5	3
DDS 552.2	Time Series Analysis				
Total		**13**	**-**	**11**	**7**

Block: 6

Course Code	Course Title	L	T	P	C
DDS 561	Deep Learning and Text Mining	3	-	10	3
DDS 563	Bayesian Statistical Modelling	5	-	5	3
DDS 564	Data Engineering	-	-	-	2
Total		**8**	**-**	**15**	**8**

SECOND YEAR

Block: August - September

Course Code	Course Title	L	T	P	C
DDS 671	Programming in SAS for Analytics	-	-	10	2
DDS 672	Statistical Research Methodology	5	-	10	4
DDS 673	Applied Data Analytics	-	-	10	2
Total		**5**	**-**	**30**	**8**

Block: October - July

Course Code	Course Title	L	T	P	C
DDS 681	Internship	-	-	-	Nil
DDS 699	Project	-	-	-	15
Total					**15**

DURING THE PROGRAMME				
DDS 682: Seminars / Journal / Term Paper Presentation (3 presentations)				3
DDS 683: Statistical Consultancy (40 consultations)				1
CHOICE BASED ELECTIVES				6

Name of the Institution / Department:

DEPARTMENT OF DATA SCIENCE, PRASANNA SCHOOL OF PUBLIC HEALTH

Name of the Programme:	M.Sc. (Data Science)
Course Title:	Computational Mathematics
Course Code:	DDS 511
Academic Year: 2022–2023	**Block:** First Year, Block 1
No of Credits: 3	**Prerequisites:** First course on Linear Algebra, Graph theory, Differential Calculus, and Integral Calculus.
Synopsis:	To provide necessary foundations of Linear Algebra, Matrix Theory, Graphs, Differential Calculus and Numerical Methods for the applications in Applied Statistics and Data Science.

Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Apply the theory of matrices and system of linear equations in related problems. (C3)
CO 2:	Carry over the computations using theory of vector spaces. (C5)
CO 3:	Use different decompositions of matrices to solve applicative problems. (C6)
CO 4:	Discuss on different types of graphs. Apply the graph theoretic algorithms in related problems. (C3)
CO 5:	Discuss and apply the theory of differential calculus. (C6)
CO 6:	Solve algebraic and transcendental equations. Differentiate and integrate given function using numerical methods. (C3)
CO 7:	Perform matrix operations, plotting different graphs and solving problems of numerical methods using SAGEMATH software. (C3)

Mapping of COs to POs

COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*
CO 1	✓				✓	✓				✓
CO 2	✓				✓	✓	✓			✓
CO 3	✓				✓					
CO 4	✓						✓			✓
CO 5	✓					✓				
CO 6	✓				✓	✓				
CO 7	✓				✓		✓			✓

Name of the Institution / Department:

DEPARTMENT OF DATA SCIENCE, PRASANNA SCHOOL OF PUBLIC HEALTH

Name of the Programme:	M.Sc. (Data Science)
Course Title:	Probability and Probability Distributions
Course Code:	DDS 512
Academic Year: 2022–2023	**Block:** First Year, Block 1
No of Credits: 3	**Prerequisites:** Set Theory, Calculus, Descriptive Statistics
Synopsis:	To provide a necessary foundation in probability and probability distributions to model and analyze real-world scenarios.
Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Describe different approaches to probability and summarize its elementary theorems. (C6)
CO 2:	Distinguish between discrete and continuous random variables and identify when and how to use their corresponding distributions. (C4)
CO 3:	Relate marginal, conditional, and joint distribution functions. (C6)
CO 4:	Evaluate the expectation of a linear combination of random variables. (C6)
CO 5:	Identify different probability distributions and their relationships with other probability distributions. (C4)
CO 6:	Illustrate different forms of convergence, the law of large numbers and central limit theorem. (C4)
CO 7:	Identify the exponential family of distributions and summarize its properties. (C2)

Mapping of COs to POs

COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*
CO 1	✓									
CO 2	✓				✓	✓				
CO 3	✓									
CO 4	✓									
CO 5	✓				✓	✓				
CO 6	✓				✓	✓				
CO 7	✓									

Name of the Institution / Department:

DEPARTMENT OF DATA SCIENCE, PRASANNA SCHOOL OF PUBLIC HEALTH

Name of the Programme:	M.Sc. (Data Science)
Course Title:	Programming with R and Python
Course Code:	DDS 513
Academic Year: 2022–2023	**Block:** First Year, Block 1
No of Credits: 2	**Prerequisites:** Basic Mathematics – Matrix and Vector Operations and Basic Programming Skills
Synopsis:	To acquaint students to program in R/Python for effective data analysis. The course covers practical issues in statistical computing which includes programming with R/Python, reading data into R/Python, accessing R/Python packages, writing R/Python functions, debugging, profiling R/Python code, organizing and commenting R/Python code. Topics in data analysis will provide working examples in order to enhance data management and analytical skills.
Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Access online resources for R/Python and import new function and packages into the R/Python workspace. (C3)
CO 2:	Construct and execute programs in R using elementary programming techniques, assign and manipulate data structures, create user-defined functions, loops, condition statements and debugging. (C5)
CO 3:	Import, manipulate and summarize datasets with R/Python. (C4)
CO 4:	Perform exploratory analysis using R/Python. (C4)
CO 5:	Demonstrate ability to create and edit visualizations with R/Python. (C5)
CO 6:	Design and evaluate advanced algorithms in R/Python. (C6)

Mapping of COs to POs

COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*
CO 1	✓	✓					✓	✓	✓	
CO 2	✓	✓			✓	✓	✓		✓	✓
CO 3	✓	✓			✓		✓	✓	✓	
CO 4	✓	✓			✓	✓	✓		✓	
CO 5	✓	✓				✓	✓		✓	
CO 6	✓	✓			✓	✓	✓		✓	✓

Name of the Institution / Department:

DEPARTMENT OF DATA SCIENCE, PRASANNA SCHOOL OF PUBLIC HEALTH

Name of the Programme:	M.Sc. (Data Science)
Course Title:	Statistical Inference
Course Code:	DDS 521
Academic Year: 2022–2023	**Block:** First Year, Block 2
No of Credits: 3	**Prerequisites:** Knowledge of descriptive statistics, random sampling, probability and basic probability distributions.
Synopsis:	To acquaint students with fundamentals of estimation and hypothesis testing so as to analyse data by appropriate parametric tests/inferential techniques and interpret the results.

Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Illustrate some statistical methods to find point estimators of population parameters and list their properties. (C4)
CO 2:	Describe concepts of sampling distribution, probability distributions of various sample statistics and illustrate their usefulness. (C4)
CO 3:	Explain the principles of estimation and hypothesis testing. (C4)
CO 4:	Derive best "point estimates" and "confidence intervals" for population parameters based on corresponding sample statistics. (C4)
CO 5:	Explain the concept of normality checking and robustness of non-parametric tests. (C2)
CO 6:	Perform best "hypothesis tests" for the population parameters. (C4)
CO 7:	Determine the sample size necessary for estimating a population parameter with certain level of confidence and to conduct a hypothesis test with specified power. (C4)
CO 8:	Analyse and interpret results from basic parametric and non-parametric tests. (C4)
CO 9:	Formulate a statistical problem from a real-life situation, understand the implications and limitations of various statistical methods; apply most appropriate method; interpret the findings. (C6)

Mapping of COs to POs

COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*
CO 1	✓						✓		✓	
CO 2	✓						✓		✓	
CO 3	✓						✓		✓	
CO 4	✓	✓	✓	✓			✓		✓	
CO 5	✓	✓	✓	✓			✓		✓	
CO 6	✓	✓	✓	✓			✓		✓	
CO 7	✓	✓	✓	✓			✓		✓	
CO 8	✓	✓		✓			✓		✓	
CO 9	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Name of the Institution / Department:

DEPARTMENT OF DATA SCIENCE, PRASANNA SCHOOL OF PUBLIC HEALTH

Name of the Programme:	M.Sc. (Data Science)
Course Title:	Data Processing, Data Management and Data Warehousing
Course Code:	DDS 522
Academic Year: 2022–2023	**Block:** First Year, Block 2
No of Credits: 3	**Prerequisites:** NIL
Synopsis:	This course introduces the student to • The concept of data management in the applications developed using database • The evolution of database from file system to RDBMS • Design an efficient database • The concept of data warehouse • The concepts of big data and data handling
Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Apply data pre-processing techniques on real life data
CO 2:	Illustrate the evolution of database. (C3)
CO 3:	Identify the concepts of DBMS, relational data model, steps involved in design the RDBMS system. (C2)
CO 4:	Describe the concept and significance of normalization and practice designing the data model sticking to normalization techniques. (C2)
CO 5:	Identify the need for data warehouse. (C2)
CO 6:	Illustrate big data pre-processing with WEKA. (C4)

Mapping of COs to POs

COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*
CO 1	✓	✓							✓	
CO 2	✓	✓								
CO 3	✓	✓				✓				✓
CO 4	✓				✓	✓				
CO 5	✓	✓				✓				✓
CO 6	✓	✓			✓	✓			✓	✓

Name of the Institution / Department:

DEPARTMENT OF DATA SCIENCE, PRASANNA SCHOOL OF PUBLIC HEALTH

Name of the Programme:	M.Sc. (Data Science)
Course Title:	Linear Regression Models
Course Code:	DDS 531
Academic Year: 2022–2023	**Block:** First Year, Block 3
No of Credits: 2	**Prerequisites:** Computational Mathematics, Probability and Probability Distributions, Statistical Inference
Synopsis:	To provide necessary foundation to build regression models and apply it on real life data for meaningful interpretation.
Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Develop a deeper understanding of the linear regression model, its assumptions, applications, advantages and limitations. (C5)
CO 2:	Predict with linear regression models, interpret estimates and diagnostic statistics thus obtained. (C6)
CO 3:	Describe the theory underlying point estimation, hypothesis tests, confidence intervals and model adequacy for linear regression models. (C2)
CO 4:	Evaluate and apply corrections to problems with the linear model such as multicollinearity, autocorrelation, heteroscedasticity and presence of leverage in the real life data. (C6)

Mapping of COs to POs

COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*
CO 1	✓	✓					✓		✓	
CO 2	✓	✓			✓	✓	✓	✓	✓	
CO 3	✓	✓							✓	✓
CO 4	✓	✓			✓	✓	✓	✓	✓	✓

Name of the Institution / Department:

DEPARTMENT OF DATA SCIENCE, PRASANNA SCHOOL OF PUBLIC HEALTH

Name of the Programme:	M.Sc. (Data Science)
Course Title:	Categorical Data Analysis and Generalized Linear Models
Course Code:	DDS 532
Academic Year: 2022–2023	**Block:** First Year, Block 3
No of Credits: 3	**Prerequisites:** Computational Mathematics, Probability and Probability Distributions, Statistical Inference.
Synopsis:	To provide necessary foundation in theory, methods, analysis, interpretation and reporting of generalized linear models.
Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Identify the categorical variables involved and choose appropriate tests of association and effect measures. (C3)
CO 2:	Apply appropriate model based on the outcome variable. (C3)
CO 3:	Explain the procedure of conditional logistic regression. (C2)
CO 4:	Illustrate the methods of model building in generalized linear models. (C4)
CO 5:	Illustrate the methods of model validation in generalized linear models. (C4)
CO 6:	Demonstrate non-parametric approaches of regression models and implement appropriate ones on real life data. (C3)

Mapping of COs to POs

COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*
CO 1	✓	✓			✓	✓	✓		✓	✓
CO 2	✓	✓			✓	✓	✓		✓	✓
CO 3	✓	✓			✓	✓	✓		✓	✓
CO 4	✓	✓			✓	✓	✓		✓	✓
CO 5	✓	✓			✓	✓	✓		✓	✓
CO 6	✓	✓			✓	✓	✓		✓	✓
CO 7	✓	✓			✓	✓	✓		✓	✓

Name of the Institution / Department:

DEPARTMENT OF DATA SCIENCE, PRASANNA SCHOOL OF PUBLIC HEALTH

Name of the Programme:	M.Sc. (Data Science)
Course Title:	Distributed Algorithms and Optimization with Hadoop and Spark
Course Code:	DDS 533
Academic Year: 2022–2023	**Block:** First Year, Block 3
No of Credits: 3	**Prerequisites:** Basic knowledge of JAVA.
Synopsis:	This course gives the insight of parallel computations and distribution cost of algorithms. Student gets hands-on working with parallel algorithms and map reduce technique.

Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Describes fundamentals of distributed and parallel algorithms. (C2)
CO 2:	Explain minimum spanning trees and stochastic gradient descent optimizer. (C2)
CO 3:	Describe communication patterns and sampling. (C2)
CO 4:	Demonstrates map reduce applications. (C3)
CO 5:	Explains measures of complexity and triangle count. (C2)
CO 6:	Demonstrate distributed computing using spark. (C3)

Mapping of COs to POs

COs	***PO 1***	***PO 2***	***PO 3***	***PO 4***	***PO 5***	***PO 6***	***PO 7***	***PO 8***	***PO 9***	***PO 10***
CO 1	✓									
CO 2	✓									
CO 3	✓									
CO 4		✓			✓					
CO 5	✓									
CO 6		✓			✓					

Name of the Institution / Department:

DEPARTMENT OF DATA SCIENCE, PRASANNA SCHOOL OF PUBLIC HEALTH

Name of the Programme:	M.Sc. (Data Science)
Course Title:	Stochastic Processes
Course Code:	DDS 541
Academic Year: 2022–2023	**Block:** First Year, Block 4
No of Credits: 3	**Prerequisites:** Computational Mathematics, Probability and Probability Distributions
Synopsis:	To provide an insight into stochastic theory and to enable the students to deal with the branching process, random walks, Markov processes, Poisson process, Birth and death processes as applied to real life scenarios.
Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Discuss the concept of stochastic and stationary processes. (C2)
CO 2:	Illustrate Poisson process and summarize its properties. (C5)
CO 3:	Differentiate between types of Markov chains and classify them. (C4)
CO 4:	Describe the concepts of birth and death process along with branching process. (C2)
CO 5:	Illustrate stochastic processes using R programming. (C5)

Mapping of COs to POs

COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*
CO 1	✓				✓	✓				
CO 2	✓				✓	✓				
CO 3	✓				✓	✓				
CO 4	✓				✓	✓				
CO 5	✓				✓	✓				

Name of the Institution / Department:

DEPARTMENT OF DATA SCIENCE, PRASANNA SCHOOL OF PUBLIC HEALTH

Name of the Programme:	M.Sc. (Data Science)
Course Title:	Design and Analysis of Experiments
Course Code:	DDS 542
Academic Year: 2022–2023	**Block:** First Year, Block 4
No of Credits: 3	**Prerequisites:** Statistical Inference
Synopsis:	The course introduces the student to commonly used experimental designs in the context of data science. The student will be able to analyse and interpret the findings in a business framework.
Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Illustrate the concepts of parallel group designs and methods to control for prognostic variables. (C3)
CO 2:	Demonstrate repeated measures design when the response variable is of either univariate or multivariate nature. (C3)
CO 3:	Identify appropriate research design in the context of real-world problems and analyse the data for meaningful interpretation. (C4)
CO 4:	Explain the notion of Latin squares designs and cross over design and apply it to the real-world problems. (C5)
CO 5:	Illustrate the concepts of balanced incomplete block designs and compare its efficiency with the randomised block design. (C4)
CO 6:	Analyse the factorial experiments. (C4)

Mapping of COs to POs

COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*
CO 1	✓	✓	✓		✓	✓				
CO 2	✓	✓	✓		✓	✓				
CO 3	✓	✓	✓		✓	✓		✓	✓	
CO 4	✓				✓	✓				
CO 5	✓				✓	✓				
CO 6	✓				✓	✓				

Name of the Institution / Department:

DEPARTMENT OF DATA SCIENCE, PRASANNA SCHOOL OF PUBLIC HEALTH

Name of the Programme:	M.Sc. (Data Science)
Course Title:	Longitudinal Data Analysis
Course Code:	DDS 543
Academic Year: 2022–2023	**Block:** First Year, Block 4
No of Credits: 3	**Prerequisites:** Computational Mathematics, Probability and Probability Distribution, Statistical Inference, Linear Regression Models and Generalized Linear Models.
Synopsis:	To provide necessary foundation in theory, methods, analysis, interpretation and reporting of parametric and non-parametric methods used in time to event data, hierarchical continuous and discrete data.
Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Describe goals of survival/reliability analysis and types of censoring, relate functions of survival/failure time. (C2)
CO 2:	Describe and interpret non-parametric methods to estimate survival functions and comparing survival distributions. (C2)
CO 3:	Identify commonly used survival distributions and discuss methods used for comparing two survival distributions. (C2)
CO 4:	Illustrate the estimation and interpretation the coefficients of GLM models with time to event outcomes for time dependent and time independent covariates. (C3)
CO 5:	Outline the concept of hierarchical data and design which lead to it. (C1)
CO 6:	Outline the concept of design effect and intra class correlation in context of hierarchical data. (C1)
CO 7:	Illustrate the concepts of random effects and fixed effects in context of linear mixed model. (C3)
CO 8:	Illustrate the model fitting, interpretation of coefficients in linear mixed and covariance pattern model. (C3)
CO 9:	Illustrate model fitting, interpretation of coefficients in generalised linear mixed and covariance pattern model for discrete data. (C3)

Mapping of COs to POs										
COs	***PO 1***	***PO 2***	***PO 3***	***PO 4***	***PO 5***	***PO 6***	***PO 7***	***PO 8***	***PO 9***	***PO 10***
CO 1	✓	✓	✓							
CO 2	✓	✓	✓	✓						
CO 3	✓	✓	✓		✓					✓
CO 4	✓	✓	✓					✓	✓	
CO 5	✓	✓	✓			✓	✓			
CO 6	✓	✓	✓			✓				✓
CO 7	✓	✓	✓							
CO 8	✓	✓	✓			✓	✓			
CO 9	✓	✓	✓			✓				✓

Name of the Institution / Department:

DEPARTMENT OF DATA SCIENCE, PRASANNA SCHOOL OF PUBLIC HEALTH

Name of the Programme:	M.Sc. (Data Science)
Course Title:	Statistical Methods for Machine Learning
Course Code:	DDS 551
Academic Year: 2022–2023	**Block:** First Year, Block 5
No of Credits: 4	**Prerequisites:** Computational Mathematics, Statistical Inference, Linear Regression Models and Generalised Linear Models.
Synopsis:	The course introduces the student to machine learning methods that will enable him/her to observe patterns in multivariate data which will supplement decision-making in real-life data-centric problems.

Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Express the structure of multivariate data through suitable visualizations and descriptive statistics and interpret the concept of multivariate normality. (C3)
CO 2:	Illustrate the utility of statistical inference on mean vectors and choose appropriate test procedures for real datasets. (C3)
CO 3:	Examine the concept of supervised learning and illustrate the concepts of discrimination and classification. (C4)
CO 4:	Appraise the concept of dimension reduction and differentiate between principal component analysis and factor analysis. (C4)
CO 5:	Distinguish between supervised and unsupervised learning and examine hierarchical, partition-based and semi-supervised methods for clustering. (C4)
CO 6:	Appraise various statistical methods in the context of machine learning and apply appropriate methods to real-life datasets. (C4)

Mapping of COs to POs

COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*
CO 1	✓				✓					
CO 2	✓				✓					
CO 3	✓	✓			✓	✓	✓		✓	
CO 4	✓	✓			✓	✓	✓		✓	
CO 5	✓	✓			✓	✓			✓	
CO 6	✓	✓			✓	✓	✓	✓	✓	✓

Name of the Institution / Department:

DEPARTMENT OF DATA SCIENCE, PRASANNA SCHOOL OF PUBLIC HEALTH

Name of the Programme:	M.Sc. (Data Science)
Course Title:	Non-parametric and Non-linear Regression
Course Code:	DDS 552.1
Academic Year: 2022–2023	**Block:** First Year, Block 5
No of Credits: 3	**Prerequisites:** Computational Mathematics, Probability and Probability Distributions, Statistical Inference and Generalized Linear Models
Synopsis:	To provide necessary foundation in non-linear and non-parametric regression techniques and to apply these techniques in prediction of real life data sets.
Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Outline basic concept of non-parametric regression and its difference from linear and generalize linear models. (C4)
CO 2:	Identify different smoothing techniques used in non-parametric regression and infer about selection of smoothing parameter and validating it. (C4)
CO 3:	Extend the univariate smoothing techniques to multivariable setup and knowledge of fitting and interpreting the model. (C4)
CO 4:	Introduce non-linear regression and growth curve models and identify its applications. (C4)
CO 5:	Identify non-linear mixed models for count, longitudinal, pharmacodynamics and pharmacokinetic data. (C4)

Mapping of COs to POs

COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*
CO 1	✓	✓	✓	✓	✓	✓				
CO 2	✓	✓	✓			✓				
CO 3	✓	✓	✓			✓				
CO 4	✓	✓	✓			✓				
CO 5	✓	✓	✓	✓	✓	✓				

Name of the Institution / Department:

DEPARTMENT OF DATA SCIENCE, PRASANNA SCHOOL OF PUBLIC HEALTH

Name of the Programme:	M.Sc. (Data Science)
Course Title:	Time Series Analysis
Course Code:	DDS 552.2
Academic Year: 2022–2023	**Block:** First Year, Block 5
No of Credits: 3	**Prerequisites:** Probability and Probability Distributions, Generalised Linear Models and Stochastic Processes
Synopsis:	To introduce the concept of time series analysis and to acquaint students with the components of time series, commonly used models and its diagnostics.
Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Explain the characteristic of time series data. (C2)
CO 2:	Apply the exponential smoothing, Box-Jenkins ARIMA and SARIMA techniques for the analysis of a time series data. (C3)
CO 3:	Describe stationary and non-stationary time series models. (C4)
CO 4:	Construct new time series models. (C5)
CO 5:	Analyse the time series with missing data and outliers. (C4)
CO 6:	Develop time series regression models for real world datasets. (C5)

Mapping of COs to POs

COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*
CO 1	✓	✓			✓	✓	✓		✓	✓
CO 2	✓	✓			✓	✓	✓		✓	✓
CO 3	✓	✓			✓	✓	✓		✓	✓
CO 4	✓	✓			✓	✓	✓		✓	✓
CO 5	✓	✓			✓	✓	✓		✓	✓
CO 6	✓	✓			✓	✓	✓		✓	✓

Name of the Institution / Department:

DEPARTMENT OF DATA SCIENCE, PRASANNA SCHOOL OF PUBLIC HEALTH

Name of the Programme:	M.Sc. (Data Science)
Course Title:	Deep Learning and Text Mining
Course Code:	DDS 561
Academic Year: 2022–2023	**Block:** First Year, Block 6
No of Credits: 3	**Prerequisites:** Basic Programming Skills
Synopsis:	The course covers various topics of machine learning algorithms (support vector machines), types of machine learning (supervised, unsupervised and reinforcement learning). The course also covers the need for deep learning for performance scaling when analysing large data. After taking this course, students will be prepared to face real-world challenges and build applications to execute faster decisions, better decisions, and interactive analysis, applied to a wide variety of use cases, architectures, and industries. Participants will learn to use NLP to perform real-time processing on streaming data from a variety of sources.
Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Describe the concepts of a machine learning algorithm. (C2)
CO 2:	Illustrate artificial neurons and back propagation algorithm. (C3)
CO 3:	Apply CNN architecture to solve a computation problem using the TensorFlow framework. (C3)
CO 4:	Describe NLP and apply it to solve real life problems on text mining. (C6)
CO 5:	Evaluate case studies by application of appropriate deep learning and text mining algorithms. (C6)

Mapping of COs to POs

COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*
CO 1	✓		✓		✓	✓	✓			
CO 2	✓				✓	✓	✓			✓
CO 3	✓	✓			✓	✓	✓			✓
CO 4	✓	✓	✓		✓	✓	✓		✓	✓
CO 5	✓	✓	✓		✓	✓	✓			✓

Name of the Institution / Department:

DEPARTMENT OF DATA SCIENCE, PRASANNA SCHOOL OF PUBLIC HEALTH

Name of the Programme:	M.Sc. (Data Science)
Course Title:	Bayesian Statistical Modelling
Course Code:	DDS 563
Academic Year: 2022–2023	**Block:** First Year, Block 6
No of Credits: 3	**Prerequisites:** Probability and Probability Distributions, Statistical Inference, Generalized Linear Models and Stochastic Processes.
Synopsis:	To understand the concepts of Bayesian modelling and predictive model comparisons and to be able to apply the Bayesian concepts in inference and model building.
Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Infer from posterior densities using Gibbs sampling and MCMC sampling. (C4)
CO 2:	Apply Bayesian concepts to real-world problems of densities such as univariate and multivariate normal, binary data and Poisson for event counts. (C3)
CO 3:	Illustrate the use of Bayesian methods in model selection and comparison. (C3)
CO 4:	Analyse some common regression models from a Bayesian perspective. (C4)

Mapping of COs to POs

COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*
CO 1	✓	✓			✓	✓	✓		✓	
CO 2	✓	✓			✓	✓	✓		✓	
CO 3	✓	✓			✓	✓	✓		✓	
CO 4	✓	✓			✓	✓	✓		✓	

Name of the Institution / Department:

DEPARTMENT OF DATA SCIENCE, PRASANNA SCHOOL OF PUBLIC HEALTH

Name of the Programme:	M.Sc. (Data Science)
Course Title:	Programming for Analytics
Course Code:	DDS 671
Academic Year: 2022–2023	**Block:** Second Year, August – September
No of Credits: 2	**Prerequisites:** All courses offered till Block 6.
Synopsis:	This course intends to develop programming skills in SAS; advanced programming in R, Python, Hadoop and Spark that are required to analyse data from real-world scenarios and generate appropriate reports of analytics from the software.
Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Perform import and export procedures in SAS. (C2)
CO 2:	Execute various procedures in SAS. (C3)
CO 3:	Employ SAS for statistical analysis. (C3)
CO 4:	Use SQL and macros in SAS. (C3)
CO 5:	Perform regression modelling, machine learning, deep learning and text mining with R, Python, Hadoop, Spark and SAS. (C3)
CO 6:	Write analysis reports in standard format. (C4)

Mapping of COs to POs

COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*
CO 1	✓	✓							✓	
CO 2	✓	✓			✓	✓	✓		✓	
CO 3	✓	✓			✓	✓	✓		✓	
CO 4	✓	✓			✓	✓	✓		✓	
CO 5	✓	✓			✓	✓	✓	✓	✓	
CO 6	✓	✓	✓					✓	✓	

Name of the Institution / Department:

DEPARTMENT OF DATA SCIENCE, PRASANNA SCHOOL OF PUBLIC HEALTH

Name of the Programme:	M.Sc. (Data Science)
Course Title:	Statistical Research Methodology
Course Code:	DDS 672
Academic Year: 2022–2023	**Block:** Second Year, August - September
No of Credits: 4	**Prerequisites:** All courses offered till Block 6.
Synopsis:	To provide the necessary foundation to simulate data and apply Markov Chain Monte Carlo (MCMC) techniques.
Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Outline the methodologies to carry out a research study. (C4)
CO 2:	Reproduce appropriate methods of simulation. (C1)
CO 3:	Demonstrate construction and analysis of simulation models. (C3)
CO 4:	Apply the techniques of simulation and MCMC. (C3)
CO 5:	Summarize how simulation and MCMC tools are used in industries to solve real-time problems. (C6)
CO 6:	Estimate and predict using MCMC. (C6)

Mapping of COs to POs

COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*
CO 1	✓	✓	✓		✓		✓	✓	✓	✓
CO 2	✓				✓	✓	✓		✓	✓
CO 3	✓				✓	✓	✓		✓	✓
CO 4	✓				✓	✓	✓		✓	✓
CO 5	✓				✓	✓	✓		✓	✓
CO 6	✓				✓	✓	✓		✓	✓

Name of the Institution / Department:

DEPARTMENT OF DATA SCIENCE, PRASANNA SCHOOL OF PUBLIC HEALTH

Name of the Programme:	M.Sc. (Data Science)
Course Title:	Applied Data Analytics
Course Code:	DDS 673
Academic Year: 2022–2023	**Block:** Second Year, August - September
No of Credits: 3	**Prerequisites:** All courses until Block 6.
Synopsis:	To understand the management and analysis of big data in health/business sector, apply analytical techniques on real data and interpret the findings.
Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Perform exploratory and inferential procedures, fit models using dedicated statistical software. (C6)
CO 2:	Identify the analytical methods to solve a real world problem. (C4)
CO 3:	Compare the performance of multiple methods and models, recognize the connections between how the data were collected and the scope of conclusions from the resulting analysis. (C6)
CO 4:	Design multiple strategies to construct models and use different measures of model fit and performance to assess models. (C5)
CO 5:	Justify an approach used and predict based on the real life data. (C6)
CO 6:	Formulate an algorithm and plan for appropriate solutions. (C5)

Mapping of COs to POs

COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*
CO 1	✓	✓			✓				✓	
CO 2	✓	✓			✓				✓	
CO 3	✓	✓			✓	✓	✓	✓	✓	
CO 4	✓	✓			✓	✓	✓	✓	✓	✓
CO 5	✓	✓			✓	✓	✓	✓	✓	✓
CO 6	✓	✓			✓	✓	✓	✓	✓	✓

Name of the Institution / Department:

DEPARTMENT OF DATA SCIENCE, PRASANNA SCHOOL OF PUBLIC HEALTH

Name of the Programme:	M.Sc. (Data Science)
Course Title:	Internship
Course Code:	DDS 681
Academic Year: 2022–2023	**Block:** Second Year, October – July
No of Credits: NIL	**Prerequisites:** Cumulative knowledge of all courses covered in the curriculum of the programme.

Synopsis:	Satisfactory completion of supervised internship is an essential requirement for any student to obtain degree in the program. Student may opt any approved institution/organization for his/her internship for the duration of minimum 6 months and the activities of internship will be reported along with the project report and consultancy report to department by the end of second year prior to the examination.

Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Cultivate work habits and attitudes necessary for job success. (A5)
CO 2:	Develop communication, interpersonal and other professional skills required for a successful career. (A5)
CO 3:	Integrate knowledge of courses covered in the curriculum of the programme and its application in real life scenarios. (C6)

Mapping of COs to POs

COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*
CO 1		✓	✓	✓				✓	✓	
CO 2		✓	✓	✓				✓	✓	
CO 3	✓	✓			✓	✓	✓	✓	✓	✓

Name of the Institution / Department:

DEPARTMENT OF DATA SCIENCE, PRASANNA SCHOOL OF PUBLIC HEALTH

Name of the Programme:	M.Sc. (Data Science)
Course Title:	Seminars / Journal / Term Paper Presentation
Course Code:	DDS 682
Academic Year: 2022–2023	**Block:** NA
No of Credits: 3	**Prerequisites:** Cumulative knowledge of courses covered in the curriculum of the programme until the presentation.
Synopsis:	In this course, every student is assigned one seminar, one journal article and one seminar/journal/accepted manuscript to be presented to a discussion forum comprising of their peers, mentors, research scholars and faculty of the department. The presentation can be assigned to an individual student or a team of students who will be assessed based on their presentation and communication skills. A report of the same has to be submitted to the department by presenters within two weeks from the presentation date.
Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Identify relevant information, define and summarize topics discussed. (C6)
CO 2:	Evaluate a methodology, structure their oral work and synthesize information. (C5)
CO 3:	Apply relevant theory to analyse real life scenarios. (C4)
CO 4:	Display command on voice modulation and pace. (A5)
CO 5:	Build on discussions fruitfully and manage to connect with the discussion panel through active participation. (C3, A5)
CO 6:	Exhibit their understanding of seminars/journals presented and spark further discussion. (C3, A5)

Mapping of COs to POs

COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*
CO 1	✓	✓							✓	
CO 2	✓	✓			✓	✓	✓	✓	✓	✓
CO 3	✓	✓			✓	✓	✓	✓	✓	✓
CO 4		✓	✓	✓				✓	✓	
CO 5	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO 6	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Name of the Institution / Department:

DEPARTMENT OF DATA SCIENCE, PRASANNA SCHOOL OF PUBLIC HEALTH

Name of the Programme:	M.Sc. (Data Science)
Course Title:	Statistical Consultancy
Course Code:	DDS 683
Academic Year: 2022–2023	**Block:** NA
No of Credits: 1	**Prerequisites:** Cumulative knowledge of courses covered in the curriculum of the programme until the consultation.
Synopsis:	In this course, every student is required to independently provide consultations to all levels of researchers under the guidance of faculty in the department. The consultation can be assigned to an individual student or a team of students who will be assessed based on their analytical and interpretation skills. A report of the same has to be submitted along with the project and internship report.
Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Develop techniques required to connect with researcher's domain to attain a clear understanding of the researcher's needs. (C6)
CO 2:	Evaluate a methodology, apply analytical skills and synthesize information. (C6)
CO 3:	Write concise, comprehensive and understandable reports. (C5)
CO 4:	Integrate knowledge of courses covered in the curriculum of the programme to analyse the data based on the study objectives (C6)

Mapping of COs to POs

COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*
CO 1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO 2	✓	✓	✓		✓	✓	✓	✓	✓	✓
CO 3	✓	✓	✓		✓	✓	✓	✓	✓	✓
CO 4	✓	✓	✓		✓	✓	✓	✓	✓	✓

Name of the Institution / Department:

DEPARTMENT OF DATA SCIENCE, PRASANNA SCHOOL OF PUBLIC HEALTH

Name of the Programme:	M.Sc. (Data Science)
Course Title:	Project
Course Code:	DDS 699
Academic Year: 2022–2023	**Block:** Second Year, October – July
No of Credits: 15	**Prerequisites:** Cumulative knowledge of all courses covered in the first three Blocks' curriculum of the programme.
Synopsis:	Every student shall carried out an industrial/research project, on the approval of faculty committee, in the second year. Project will be supervised by a faculty (internal and/or external) who is responsible for student's continuous assessment. Project report must be submitted before the end of second year which is necessary for the final evaluation.
Course Outcomes (COs):	On successful completion of this course, students will be able to
CO 1:	Demonstrate depth of understanding on the topic of project, utilize primary and secondary sources required to answer objectives of their project. (C5)
CO 2:	Apply theories, methods and knowledge bases from diverse fields to answer research question or problem. (C3)
CO 3:	Reveal clarity in the scope of their project, structure their project, synthesize information and defend the project work. (C6)
CO 4:	Exhibit persuasive speech, present information in a compelling, well-structured, and logical sequence. (A5)
CO 5:	Build on discussions fruitfully and manage to connect with the project guide and supervisors. (C3, A5)

Mapping of COs to POs

COs	*PO 1*	*PO 2*	*PO 3*	*PO 4*	*PO 5*	*PO 6*	*PO 7*	*PO 8*	*PO 9*	*PO 10*
CO 1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO 2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO 3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO 4		✓	✓	✓				✓	✓	
CO 5	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

7. PROGRAMME OUTCOMES (POs) AND COURSE OUTCOMES (COs) MAPPING

Sl #	Course Code	Course Name	Credit	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
1	DDS 511	Linear Algebra and Matrix Analysis	3	CO 1 CO 2 CO 3 CO 4 CO 5 CO 6 CO 7				CO 1 CO 2 CO 3 CO 6 CO 7	CO 1 CO 2 CO 5 CO 6	CO 2 CO 4 CO 7			CO 1 CO 2 CO 4 CO 7
2	DDS 512	Probability and Probability Distributions	3	CO 1 CO 2 CO 3 CO 4 CO 5 CO 6 CO 7				CO 2 CO 5 CO 6	CO 2 CO 5 CO 6				
3	DDS 513	Programming with R and Python	2	CO 1 CO 2 CO 3 CO 4 CO 5 CO 6	CO 1 CO 2 CO 3 CO 4 CO 5 CO 6			CO 2 CO 3 CO 4 CO 6	CO 2 CO 4 CO 5 CO 6	CO 1 CO 2 CO 3 CO 4 CO 5 CO 6	CO 1 CO 3	CO 1 CO 2 CO 3 CO 4 CO 5 CO 6	CO 2 CO 6
4	DDS 521	Statistical Inference	4	CO 1 CO 2 CO 3 CO 4 CO 5 CO 6 CO 7 CO 8 CO 9	CO 4 CO 5 CO 6 CO 7 CO 8 CO 9	CO 4 CO 5 CO 6 CO 7 CO 9	CO 4 CO 5 CO 6 CO 7 CO 8 CO 9	CO 9	CO 9	CO 1 CO 2 CO 3 CO 4 CO 5 CO 6 CO 7 CO 8 CO 9	CO 9	CO 1 CO 2 CO 3 CO 4 CO 5 CO 6 CO 7 CO 8 CO 9	CO 9
5	DDS 522	Data Processing, Data Management and Data Warehousing	3	CO 1 CO 2 CO 3 CO 4 CO 5 CO 6	CO 1 CO 2 CO 3 CO 5 CO 6			CO 4 CO 6	CO 3 CO 4 CO 5 CO 6			CO 1 CO 6	CO 3 CO 5 CO 6
6	DDS 531	Linear Regression Models	2	CO 1 CO 2 CO 3 CO 4	CO 1 CO 2 CO 3 CO 4			CO 2 CO 4	CO 2 CO 4	CO 1 CO 2 CO 4	CO 2 CO 4	CO 1 CO 2 CO 3 CO 4	CO 3 CO 4
7	DDS 532	Categorical Data Analysis and Generalized Linear Models	3	CO 1 CO 2 CO 3 CO 4 CO 5 CO 6 CO 7	CO 1 CO 2 CO 3 CO 4 CO 5 CO 6 CO 7			CO 1 CO 2 CO 3 CO 4 CO 5 CO 6 CO 7	CO 1 CO 2 CO 3 CO 4 CO 5 CO 6 CO 7	CO 1 CO 2 CO 3 CO 4 CO 5 CO 6 CO 7		CO 1 CO 2 CO 3 CO 4 CO 5 CO 6 CO 7	CO 1 CO 2 CO 3 CO 4 CO 5 CO 6 CO 7
8	DDS 533	Distributed Algorithms and Optimization with Hadoop and Spark	3	CO 1 CO 2 CO 3 CO 5	CO 4 CO 6			CO 4 CO 6					
9	DDS 541	Stochastic Processes	3	CO 1 CO 2 CO 3 CO 4 CO 5				CO 1 CO 2 CO 3 CO 4 CO 5	CO 1 CO 2 CO 3 CO 4 CO 5				
10	DDS 542	Design and Analysis of Experiments	3	CO 1 CO 2 CO 3 CO 4 CO 5 CO 6	CO 1 CO 2 CO 3	CO 1 CO 2 CO 3		CO 1 CO 2 CO 3 CO 4 CO 5 CO 6	CO 1 CO 2 CO 3 CO 4 CO 5 CO 6		CO 3	CO 3	
11	DDS 543	Longitudinal Data Modelling	3	CO 1 CO 2 CO 3 CO 4 CO 5 CO 6 CO 7 CO 8 CO 9	CO 1 CO 2 CO 3 CO 4 CO 5 CO 6 CO 7 CO 8 CO 9	CO 1 CO 2 CO 3 CO 4 CO 5 CO 6 CO 7 CO 8 CO 9	CO 2	CO 3	CO 5 CO 6 CO 8 CO 9	CO 5 CO 8	CO 4	CO 4	CO 3 CO 6 CO 9

Sl #	Course Code	Course Name	Credit	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
12	DDS 551	Statistical Methods for Machine Learning	4	CO 1 CO 2 CO 3 CO 4 CO 5 CO 6	CO 3 CO 4 CO 5 CO 6			CO 1 CO 2 CO 3 CO 4 CO 5 CO 6	CO 3 CO 4 CO 5 CO 6	CO 3 CO 4 CO 6	CO 6	CO 3 CO 4 CO 5 CO 6	CO 6
13	DDS 552.1	Non-parametric and Non-linear Regression	3	CO 1 CO 2 CO 3 CO 4 CO 5	CO 1 CO 2 CO 3 CO 4 CO 5	CO 1 CO 2 CO 3 CO 4 CO 5	CO 1 CO 6	CO 1 CO 6	CO 1 CO 2 CO 3 CO 4 CO 5				
14	DDS 552.2	Time Series and Forecasting	3	CO 1 CO 2 CO 3 CO 4 CO 5 CO 6	CO 1 CO 2 CO 3 CO 4 CO 5 CO 6			CO 1 CO 2 CO 3 CO 4 CO 5 CO 6	CO 1 CO 2 CO 3 CO 4 CO 5 CO 6	CO 1 CO 2 CO 3 CO 4 CO 5 CO 6		CO 1 CO 2 CO 3 CO 4 CO 5 CO 6	CO 1 CO 2 CO 3 CO 4 CO 5 CO 6
15	DDS 561	Deep Learning and Text Mining	3	CO 1 CO 2 CO 3 CO 4 CO 5	CO 3 CO 4 CO 5	CO 1 CO 4 CO 5		CO 1 CO 2 CO 3 CO 4 CO 5	CO 1 CO 2 CO 3 CO 4 CO 5	CO 1 CO 2 CO 3 CO 4 CO 5		CO 4	CO2 CO3 CO4 CO5
16	DDS 563	Bayesian Statistical Modelling	3	CO 1 CO 2 CO 3 CO 4	CO 1 CO 2 CO 3 CO 4			CO 1 CO 2 CO 3 CO 4	CO 1 CO 2 CO 3 CO 4	CO 1 CO 2 CO 3 CO 4		CO 1 CO 2 CO 3 CO 4	
18	DDS 671	Programming for Analytics	2	CO 1 CO 2 CO 3 CO 4 CO 5 CO 6	CO 1 CO 2 CO 3 CO 4 CO 5 CO 6	CO 6		CO 2 CO 3 CO 4 CO 5	CO 2 CO 3 CO 4 CO 5	CO 2 CO 3 CO 4 CO 5	CO 5 CO 6	CO 1 CO 2 CO 3 CO 4 CO 5 CO 6	
19	DDS 672	Statistical Research Methodology	4	CO 1 CO 2 CO 3 CO 4 CO 5 CO 6	CO 1	CO 1		CO 1 CO 2 CO 3 CO 4 CO 5 CO 6	CO 2 CO 3 CO 4 CO 5 CO 6	CO 1 CO 2 CO 3 CO 4 CO 5 CO 6	CO 1	CO 1 CO 2 CO 3 CO 4 CO 5 CO 6	CO 1 CO 2 CO 3 CO 4 CO 5 CO 6
20	DDS 673	Applied Data Analytics	2	CO 1 CO 2 CO 3 CO 4 CO 5 CO 6	CO 1 CO 2 CO 3 CO 4 CO 5 CO 6			CO 1 CO 2 CO 3 CO 4 CO 5 CO 6	CO 3 CO 4 CO 5 CO 6	CO 3 CO 4 CO 5 CO 6	CO 3 CO 4 CO 5 CO 6	CO 1 CO 2 CO 3 CO 4 CO 5 CO 6	CO 4 CO 5 CO 6
21	DDS 681	Internship	-	CO 3	CO 1 CO 2 CO 3	CO 1 CO 2	CO 1 CO 2	CO 1	CO 1	CO 1	CO 1 CO 2 CO 3	CO 1 CO 2 CO 3	CO 1
22	DDS 682	Seminars / Journal / Term Paper Presentation	3	CO 1 CO 2 CO 4 CO 5 CO 6	CO 1 CO 2 CO 3 CO 4 CO 5 CO 6	CO 4 CO 5 CO 6	CO 4 CO 5 CO 6	CO 2 CO 3 CO 5 CO 6	CO 2 CO 3 CO 5 CO 6	CO 2 CO 3 CO 5 CO 6	CO 2 CO 3 CO 4 CO 5 CO 6	CO 1 CO 2 CO 3 CO 4 CO 5 CO 6	CO 2 CO 3 CO 5 CO 6
23	DDS 683	Statistical Consultancy	1	CO 1 CO 2 CO 3 CO 4	CO 1 CO 2 CO 3 CO 4	CO 1 CO 2 CO 3 CO 4	CO 1	CO 1 CO 2 CO 3 CO 4	CO 1 CO 2 CO 3 CO 4	CO 1 CO 2 CO 3 CO 4	CO 1 CO 2 CO 3 CO 4	CO 1 CO 2 CO 3 CO 4	CO 1 CO 2 CO 3 CO 4
24	DDS 699	Project	15	CO 1 CO 2 CO 3 CO 5	CO 1 CO 2 CO 3 CO 4 CO 5	CO 1 CO 2 CO 3 CO 4 CO 5	CO 1 CO 2 CO 3 CO 4 CO 5	CO 1 CO 2 CO 3 CO 5	CO 1 CO 2 CO 3 CO 5	CO 1 CO 2 CO 3 CO 5	CO 1 CO 2 CO 3 CO 4 CO 5	CO 1 CO 2 CO 3 CO 4 CO 5	CO 1 CO 2 CO 3 CO 5