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UNIVERSITY OF STEEL TECHNOLOGY
AND MANAGEMENT

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**UNIVERSITY OF STEEL TECHNOLOGY
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Proposed Syllabus and Scheme of Examination
for
B.Sc. (Honors), Data Science and Analytics [03UG025]

Session-2023 - 24

School of Science
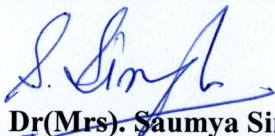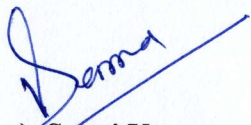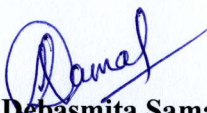## OPJU, Raigarh

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Approved scheme of teaching, examination and syllabus for Bachelor of Science in Data Science and Analytics [03UG025] Honors by the members of Board of Studies
Applicable from session 2023-24
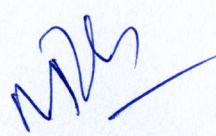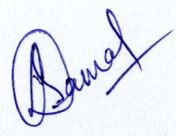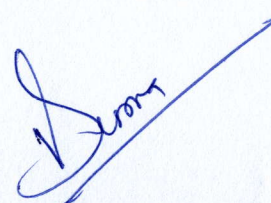
The scheme of teaching, examination and syllabus are hereby approved by the following members of Board of Studies

Internal Experts:	
Dr(Mrs). Saumya Singh Associate Professor-Mathematics	**Dr. Rakesh Nayak** Professor-CSE
Dr(Mrs). Swati Verma Associate Professor -Mathematics	**Dr. Amit Jain** Professor-CSE
Prof. M. R. Mishra Assistant Professor-Mathematics	**Dr(Mrs). Debasmita Samal** Assistant Professor-Mathematics
Dr. G. C. Mishra Associate Dean, SOS	

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Scheme of B. Sc. Hons. in Data Science and Analytics [03UG025]

Sem.	CC (14)	Credit	AECC (2)	Credit	SEC (2)	Credit	VA (2)	Credit	DSE (4)	Credit	INTERNSHIP	Credit	GE (4)	Credit	Total Credit
1	CC I	6	AECC I	2	SEC I	2							GE I	6	22
1	CC II	6	AECC I	2	SEC I	2							GE I	6	22
2	CC III	6	AECC II	2	SEC II	2							GE II	6	22
2	CC IV	6	AECC II	2	SEC II	2							GE II	6	22
3	CC V	6			SEC III	2								6	26
3	CC VI	6			SEC III	2								6	26
3	CC VII	6			SEC III	2								6	26
4	CC VIII	6			SEC IV	2	VA I	2					GE IV	6	28
4	CC IX	6			SEC IV	2	VA I	2					GE IV	6	28
4	CC X	6			SEC IV	2	VA I	2					GE IV	6	28
5	CC XI	6					VA II	2	DSE I	6					26
5	CC XII	6					VA II	2	DSE II	6					26
6	CC XIII	6					VA III	2	DSE III	6	INTERNSHIP	6			32
6	CC XIV	6					VA III	2	DSE IV	6	INTERNSHIP	6			32

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SCHEME OF TEACHING AND EXAMINATION

For CC, DSE and GE Subject (6 credit)

- o Theory (4 periods/week) + Lab (4 periods/week)

   Or

- o Theory (5 periods/week) +Tutorial (1 periods/week)

SN	Subject Code	Category	Name of Subject	Periods per week			Scheme of Examination and Marks						Total Marks	Credits: L+ (T+P)/2
				L	T	P	Theory			Practical				
							Mid Sem	TA	ESE	Mid Sem	TA	ESE		
1	CC / DSE / GE	Theory (4) + Lab (4)	4	0	4	30	20	50	-	25	25	150	6
OR														
2	CC / DSE / GE	Theory (5) + Tutorial (1)	5	1	0	45	30	75	-	-	-	150	6

For Project / Dissertation

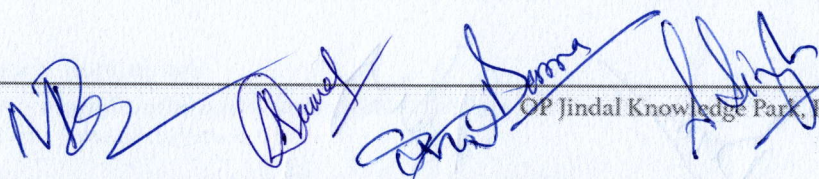| SN	Subject Code	Category	Name of Subject	Periods per week			Scheme of Examination and Marks						Total Marks	Credits: L+ (T+P)/2
				L	T	P	Theory			Practical				
							Mid Sem	TA	ESE	Mid Sem	TA	ESE		
1	DSE	Project / Dissertation	0	0	12	-	-	-	-	75	75	150	6

For AECC and SEC Subject (2 credit)

1. Theory (2)   Or   Lab (4)

SN	Subject Code	Category	Name of Subject	Periods per week			Scheme of Examination and Marks						Total Marks	Credits: L+ (T+P)/2
				L	T	P	Theory			Practical				
							Mid Sem	TA	ESE	Mid Sem	TA	ESE		
1		AECC / SEC	Theory (2)	2	0	0	-	25	25	-	-	-	50	2
OR														
2		AECC / SEC	Lab (4)	0	0	4	-	-	-	-	25	25	50	2

For VA Subject (2 credit)

SN	Subject Code	Category	Name of Subject	Periods per week			Scheme of Examination and Marks						Total Marks	Credits: L+ (T+P)/2
				L	T	P	Theory			Practical				
							Mid Sem	TA	ESE	Mid Sem	TA	ESE		
1		VA	Theory (2)	2	0	0	30	20	50	-	-	-	100	2

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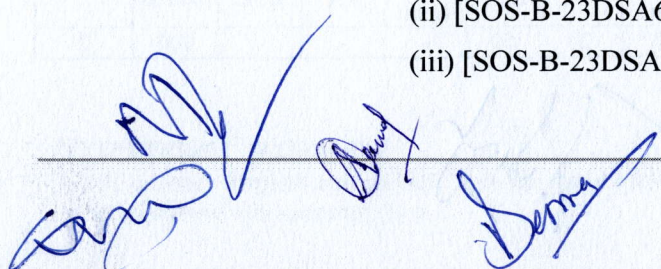## Core Course (CC) Papers: (06 Credits each)

1. CC I: Introduction to Programming [SOS-B-23DSA101]

2. CC II: Statistics-I [SOS-B-23DSA102]

3. CC III: R Programming [SOS-B-23DSA201]

4. CC IV: Database Management Systems [SOS-B-23DSA202]

5. CC V: Data Structure & Algorithms [SOS-B-23DSA301]

6. CC VI: Introduction to Computer organization [SOS-B-23DSA302]

7. CC VII: Statistics-II [SOS-B-23DSA303]

8. CC VIII: Data Preparation, Cleaning, Ware housing and Data mining [SOS-B-23DSA401]

9. CC IX: Regression, time series, forecasting and Index numbers and Statistical Inference (non-parametric) [SOS-B-23DSA402]

10. CC X: Multivariate and Statistical Analysis (Count Data and survival Analysis) [SOS-B-23DSA403]

11. CC XI: Data Scientist Toolbox [SOS-B-23DSA501]

12. CC XII: Data Visualization Techniques- TABLEAU [SOS-B-23DSA502]

13. CC XIII: Machine learning and Artificial Intelligence [SOS-B-23DSA601]

14. CC XIV: Deep Learning and Big Data Analytics [SOS-B-23DSA602]

Discipline Specific Elective (DSE) Papers: (06 Credits each)
For Vth Semester: One paper from each DSEI and DSE II
For VIth Semester: One paper from each DSE III and DSE IV

1. DSE-I :   (i) [SOS-B-23DSA503 (i)]: Text Analytics

     (ii) [SOS-B-23DSA503 (ii)]: HR Analytics

     (iii) [SOS-B-23DSA503 (iii)]: Financial Analytics

     (iv) [SOS-B-23DSA503 (iv)]: Healthcare Analytics

     (v) [SOS-B-23DSA503 (v)]: Social Media Analytics

2. DSE-II: (i) [SOS-B-23DSA504 (i)]: Recommender Systems

     (ii) [SOS-B-23DSA504 (ii)]: Reinforcement Learning

     (iii) [SOS-B-23DSA504 (iii)]: Tensor flow for Deep Learning Research

     (iv) [SOS-B-23DSA504 (iv)]: Nature Language Processing

3. DSE-III: (i) [SOS-B-23DSA603 (i)]: E-Commerce

     (ii) [SOS-B-23DSA603 (ii)]: Marketing and Retail Analytics

     (iii) [SOS-B-23DSA603 (iii)]: Supply Chain and Logistics Analytics

4. DSE-IV: (i) [SOS-B-23DSA604 (i)]: Software Quality Management

     (ii) [SOS-B-23DSA604 (ii)]: Software Testing

     (iii) [SOS-B-23DSA604 (iii)]: Data Security and Compliance

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Generic Elective (GE) Papers: (06 Credits each) (Four papers of any discipline) GE I - IV
1. Foundation course in Mathematics [SOS-B-23DSA103]
2. Differential Equations, Complex Variable and Numerical Methods [SOS-B-23DSA203]
3. Operating Systems [SOS-B-23DSA304]
4. Discrete Mathematics and Operations Research [SOS-B-23DSA404]

Ability Enhancement Compulsory Course (AECC): (02 Credits each) AECC I – II
1. Communicative English (2) (SOS-B-AE101)
2. Environmental Science (2) (SOS-B-AE201)

Skill Enhancement Courses (SEC): (02 Credits each) SEC I – IV
1. Computer Fundamentals (SOS-B-SE101)
2. Disaster Management (SOS-B-SE201)
3. Professional Development (SOS-B-SE301)
4. Introduction to MATLAB (SOS-B-SE401)

Value Added Courses (VA): (02 Credits each) VA I – III
1. Indian Knowledge System (SOS-B-VA401)
2. The One Thing and Extreme Ownership (SOS-B-VA501)
3. Public Administration (SOS-B-VA601)

Internship/Project: (06 Credits): [SOS-B-23DSA605]

Generic Elective (GE) Papers (Minor-Computer Science): (Those who choose Computer Science as a Generic elective, 06 Credits each) GE I – IV
1. GE I: Introduction to Programming [SOS-B-23DSA101]
2. GE II: Database Management Systems [SOS-B-23DSA202]
3. GE III: Data Structure & Algorithms [SOS-B-23DSA301]

    OR Introduction to Computer organization [SOS-B-23DSA302]
4. GE IV: Operating Systems [SOS-B-23DSA401]

    OR Machine learning and Artificial Intelligence [SOS-B-23DSA601]
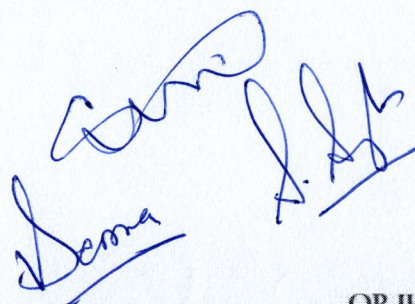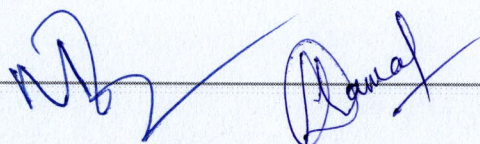
CC: Core Course

AECC: Ability Enhancement Compulsory Course

SEC: Skill Enhancement Course

DSE: Discipline Specific Elective

GE: Generic Elective

VA: Value Added Course

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Program Outcomes

PO-1: Knowledge and Problem Solving: Acquire in-depth scientific knowledge of their discipline both in theory and practical, demonstrate basic skills, investigate, apply, and solve the problems in a variety of contexts related to science and technology.

PO-2: Communication and Teamwork: Develop skills to communicate effectively to diverse platforms and contribute meaningfully to different capacities as a leader, team member or individual.

PO-3: Modern tools and techniques for Scientific Experiments: Apply modern tools and techniques to carry out scientific experiments accurately, record, analyze and predict the result for valid conclusion with clear understanding of limitations.

PO-4: Logical thinking: Develop logical thinking and expertise with precision, analytical mind, innovative thinking, clarity of thought, and systematic approach for proving or disproving the facts after mathematical formulation. with precision, analytical mind, innovative thinking, clarity of thought, expression, and systematic approach

PO-5: Skill development and Employability: develop elementary computing and soft skills to prepare students for industry, entrepreneurship and higher education with precision, analytical mind, innovative thinking, clarity of thought, expression, and systematic approach.

PO-6: Ethics and citizenship: Able to recognize different value systems and ethical principles; and commit to professional ethics, norms, and responsibilities of the science practice and act with informed awareness to participate in civic life activities.

PO-7: Society, Environment and Sustainability: Enhance ability to elicit views of others and understand the impact of various solutions in the context of societal, economic, health, legal, safety and environment for sustainable development.

PO-8: Life-long learning: Acquire fundamental knowledge for lifelong learning to participate in the extensive context of socio-technological change as a self-directed member and a leader.
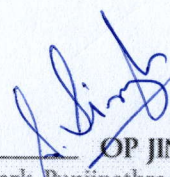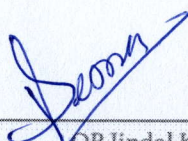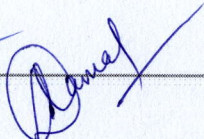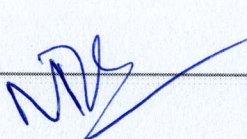
Program Specific Outcomes (PSO)

PSO1: Apply computing theory, languages and algorithms, as well as mathematical and statistical models, and the principles of optimization to appropriately formulate and use data analysis.

PSO2: Apply the principles and techniques of database design, administration, and implementation to enhance data collection capabilities and decision-support systems.

PSO3: Ability to critique the role of information and analytics in supporting business processes and functions.

PSO4: Apply the knowledge of data sciences and analytics to develop innovative and inclusive understanding to real-world issues.

PSO5: Acquire the skills necessary to think critically and communicate effectively about data sciences and analytics and allied domains.

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Programme:	B. Sc. Hons.	**Semester :**	I
Name of the Course:	Introduction to Programming	**Course Code:**	SOS-B-23DSA101
Credits :	6	**No of Hours :**	8 Hours/Week
Max Marks:	150		

Course Description:

The main emphasis of this course is to learn Programming fundamentals using Python, understand the concepts and usage data types, variables and other basic operators and control statements in Python. Introduce data Science Tools and plot data using appropriate Python visualization, Libraries

Course Outcomes:

On successful completion of this course, students will be able to:

CO Number	Course Outcome
CO1	Understand basics of Python including variable, data types, operators and various control statements.
CO2	Learn to apply the concepts of functions strings and tuples.
CO3	Learn to make use of dictionaries, sets, regular expressions and date and time in Python for various applications.
CO4	Learn Numpy and apply the concepts to various applications
CO5	Learn Pandas and Matplotlib to apply in real life situation.

Syllabus:

Unit 1:

Introduction to Python Language: Overview, Features of Python, Execution of a Python Program, Innards of Python, Python Interpreter, Comparison of Python with C and Java, Installing Python, Writing & Executing, IDLE

Data Types, Variables And Other Basic Elements: Comments, Data types-Numeric, Compound, Boolean, Dictionary, Sets, Mapping, Basic Elements of Python, Variables and Identifiers

Operators: Arithmetic operators, Assignment operators, Unary minus operator, Relational operators, Logical operators, Bitwise operators, Membership operators, Identity operators, Precedence of Operators, Associativity of Operators

Input and Output Operations: Input Function, Output Statements, Command Line Arguments

Control Statements: Control Statements- Loop Statement, The else Suite, break Statement, continue Statement, pass Statement, assert Statement, return Statement

Unit 2:

Functions: Defining & Calling a Function, Returning Results, Returning Multiple Values, Built-in Functions, Parameters and Arguments, Recursive Functions, Anonymous or Lambda Functions

Strings: Creating Strings, Working with Strings, Length of a String, Indexing & Slicing, Strings Operation, Functions of Strings, Indexing and Slicing of string,

Lists and Tuples: Lists, List Functions and Methods, List Operations, Tuples

Unit 3:

Dictionaries: Creating a Dictionary, Operators in Dictionary, Dictionary Methods, using for Loop with Dictionaries, Operations on Dictionaries, Ordered Dictionaries

Set: Creating a set, Operators in set, set Methods, Operations on set, frozen set.

Date and Time in Python: Date and Time, Date and Time Now, Combining Date and Time, Formatting Dates and Times, Finding Durations using "timedelta", Comparing Two Dates, Sorting Dates, Stopping Execution Temporarily, Knowing the Time taken by a Program, Working with Calendar Module.
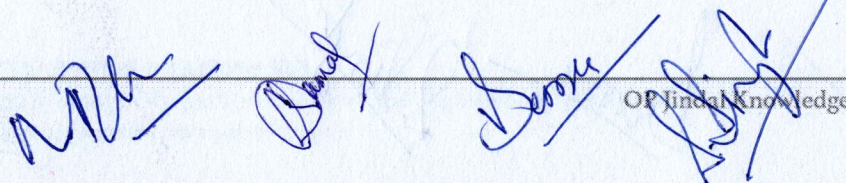
Regular Expressions: What is a Regular Expression? Rules to Generate Regular Expression, Understanding RE Modules, Quantifiers in Regular Expressions, Special Characters in Regular Expressions, Using Regular Expression on Files, Retrieving Information from an HTML File.

Unit 4:

Introduction to NumPy: Array and Matrix: Creating an Array, Initializing an array, Accessing the array elements, Describing an array, Operations in Array, Matrix Operations, Linear Algebra functions: linalg.det(), linalg.inv(), linalg.eig(), linalg.matrix_power(), linalg. solver(), Statistical Functions.

Unit 5:

Data Manipulation with Pandas: Introducing Pandas Objects, Data Structure in Pandas, Accessing Elements of a Series, Mathematical Operations on Series, DataFrame, Importing and Exporting Data between CSV Files and DataFrames, Descriptive Statistics using pandas, Data Aggregations using pandas, ROUP BY Functions, Altering the Index, Other DataFrame Operations, Handling Missing Values, Dropping Missing Values, Estimating Missing Values,

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Visualization with Matplotlib: Plotting using Matplotlib, Customisation of Plots, plotting a Line chart, Plotting Bar Chart, Plotting Histogram, Plotting Scatter Chart, Plotting Quartiles and Box plot, Plotting Pie Chart,

LIST OF PRACTICALS

1. Introduction to Python Language
a. Write a Python program to explore various data types including numeric types, Boolean types and compound types.
b. Write a Python program to perform Input and Output Operations.
c. Write a Python program to demonstrate looping in python and use of break statement and continue statement

2. Functions
a. Write a Python program to define and use functions
b. Write a Python program to demonstrate the use of Built-in Functions.
c. Write a Python Program to implement Lambda Functions.

3. Arrays and String
a. Write a Python Program to implement arrays for storing homogeneous data items. Apply indexing and slicing operations to access elements of array.
b. Write a Python Program to demonstrate operations and properties of string data types.
c. Write a Python Program implement and demonstrate the use of Membership operators and Identity operators
d. Write a Python Program to implement NumPy for handling multidimensional arrays.

4. List and Tuples
a. Write a Python Program to create list, apply various functions to it.
b. Write a Python Program to demonstrate concept of aliasing and cloning.
c. Write a Python Program to implement tuples for storing data. Verify the immutability property on tuples.

5. Dictionaries and Sets
a. Write a Python Program to implement Dictionary and operations on dictionaries
b. Write a Python Program to create sets and various operations on it.

6. Regular Expressions
a. Write a Python Program for implementing various methods for searching and replacing operations.
b. Write a Python Program for Retrieving Information from an HTML File
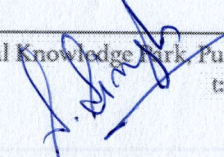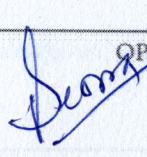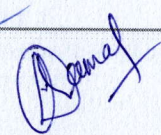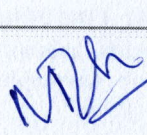
7. Date and Time
a. Write a Python Program to compare dates and implement calendar module

8. Using IPython
a. Using IPython and Jupyter notebook
b. Debugging errors in IPython.

9. Using the NumPy Package
a. Programs using NumPy Package and different functions available in it.

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10. Using the pandas package
a. Programs using Pandas Package and different functions available in it.

Text Books

1. Rakesh Nayak, Nishu Gupta, Python for Engineers and Scientists: Concepts and Applications, CRC Press, 2022
2. M. T. Savaliya, R.K, Maurya, G.M Magar, Programming through Python, Staredu Solutions 1st 2018
3. Jake Vande Plas, Python Data Science Handbook, O'Reilly Media 1st 2016
4. Y. Kanetkar, Let Us Python, BPB 1st 2019
5. Mark Summerfield, Programming in Python Pearson Education 2nd 2018
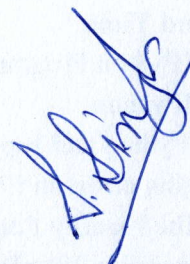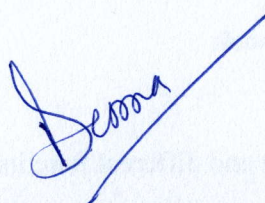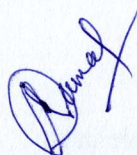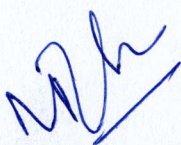
Reference Books

1. Lutz M O'Reilly- Shroff Learning Python, 5th 2013
2. Lie Hetland, Beginning Python Magnus Apress 2nd 2009
3. Star Certification, Star Python, Star Certification 1st 2018

CO-PO & PSO Correlation

Course Name: Introduction to Programming													
Program Outcomes								**PSOs**					
Course	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1:	1	1				1			1	1	1	1	1
CO2:			2							.			
CO3:		1	1			1				1	1	2	1
CO4:	1			1	2								
CO5:			1							1		1	

Note: 1: Low 2: Moderate 3: High.

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Programme:	B. Sc. Hons.	**Semester :**	I
Name of the Course:	Statistics-I	**Course Code:**	SOS-B-23DSA102
Credits :	6	**No of Hours :**	8 Hours/Week
Max Marks:	150		

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. This course is designed to introduce presentation of data- descriptive measures. This course also introduces measurement of the relationship of quantitative and qualitative data and the concept of probability. This course will enable students to understand and summarize the data, understand and apply the descriptive measures and probability for data analysis, implement theoretical concepts of descriptive measures and probability, study the relationship between variables.

Course Outcomes:

On successful completion of this course, students will be able to:

CO Number	Course Outcome
CO1	Identify the type of data and present the data in various forms and summarize it using descriptive statistics.
CO2	Understand and apply the concept of probability
CO3	Demonstrate the random variables, its generating functions and infer its expectation.
CO4	Demonstrate various discrete and continuous distributions and their usage.
CO5	Understand and apply the concept of correlation, association, regression analysis and infer its results

Syllabus

Unit 1:

Classification, tabulation, diagrammatic & graphical representation of grouped data. Frequency distributions, cumulative frequency distributions, Histogram, Ogives, frequency polygon.
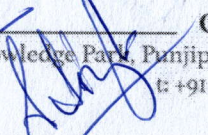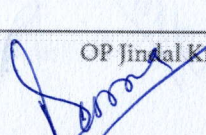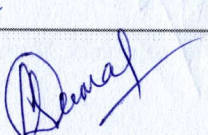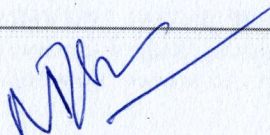Descriptive Statistics
Measures of Location or Central Tendency: Arithmetic Mean, Geometric mean, Harmonic mean. Median, Mode. Partition values: Quartiles- Deciles and Percentiles. Measures of Dispersion: Range, Mean deviation, Quartile deviation, Standard deviation, Coefficient of variation. Moments: measures of Skewness, Kurtosis. Box plot.

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Unit 2: Random experiment- sample point and sample space- event- algebra of events. Definition of Probability: classical- empirical and axiomatic approaches to probability-properties of probability. Theorems on probability- conditional probability and independent events- Laws of total probability- Baye's theorem and its applications.

Unit 3: Definition- Discrete and Continuous random variables- Probability Mass function and Probability Density function- Distribution function and its properties. Two dimensional random variables: Discrete and continuous type- Joint Density function- Marginal and Conditional Probability Mass function and Probability Density function- Independence of variables with illustration.

Expectation of single and bivariate random variables and its properties. Moments and Cumulants- moment generating function- cumulant generating function and characteristic function. Uniqueness and inversion theorems (without proof) along with applications- Conditional expectations.
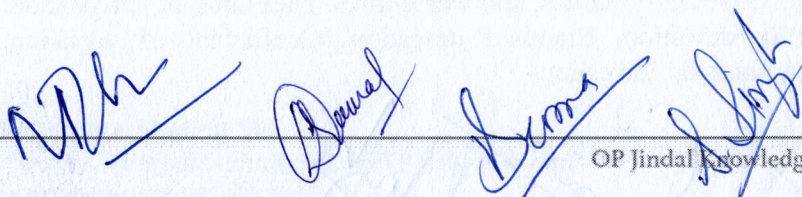
Unit 4: Discrete distributions: Binomial- Poisson- geometric- negative binomial-Hypergeometric distributions along with their properties- limiting/approximation cases and applications.
Continuous distributions: Uniform- normal- exponential- Cauchy- beta and gamma distributions along with their properties- limiting/approximation cases and applications.

Unit 5: Correlation: Scatter plot- Karl Pearson coefficient of correlation- Spearman's rank correlation coefficient- multiple and partial correlations (for 3 variates only). Regression: Concept of errors- Principles of Least Square- Simple linear regression and its properties.
Multiple linear regression, coefficient of multiple determination. Fitting of polynomials and exponential curves.

List of Programs

1. Excel worksheets: add worksheet- rename- save and delete- record worksheet and various operations on worksheet, freezing panes and splitting window.

2. Cell referencing, Linking, and conditional formatting.

3. Apply Text to column, Data validation and checks using excel.

4. Creating Pivot table and Pivot chart.

5. Apply formulas like financial, look up, maths, statistics, engineering etc.

6. Apply filter and advanced filter, sorting.

7. Diagrammatic representation and Graphical representation.

8. Descriptive statistics using statistical functions and Data Analysis Pack (DAP).

9. Exercise on correlation, Correlation matrix, partial and multiple correlation coefficient.

10. Draw a scatter plot and fit trend line for a bivariate data set

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Text Books

1. S. Ross- A First Course in Probability- 10th ed.- Pearson Education- US- 2019.
2. S.C. Gupta and V.K. Kapoor- Fundamentals of Mathematical Statistics- 12th ed.- Sultan Chand & Sons- New Delhi- 2020.
3. Irwin Miller and Marylees Miller, John E. Freund's Mathematical Statistics with Applications (8thEdition), Pearson, Asia, 2014.
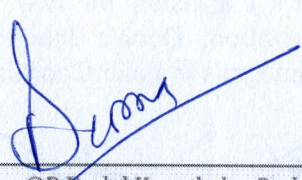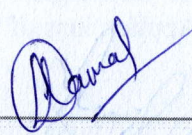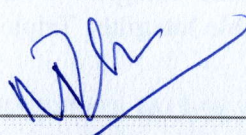
Reference Books

1. P. Mukhopadhyay - Mathematical Statistics-3rd ed. -Books and Allied (P) Ltd- Kolkata- 2018.
2. V.K. Rohatgi and E. Saleh - An Introduction to Probability and Statistics- 3rd ed.- John Wiley & Sons Inc.- New Jersey- 2015.
3. D.C. Montgomery and G.C. Runger- Applied Statistics and Probability for Engineers-7th ed.- Wiley India- New Delhi- 2018.
4. A.M. Mood-F.A. Graybill and D.C. Boes- Introduction to the Theory of Statistics-3rd ed.- McGraw Hill- New Delhi-2017.
5. Robert V. Hogg, Joseph W. McKean and Allen T. Craig, Introduction to Mathematical Statistics, Pearson Education, Asia, 2007.
6. Alexander M. Mood, Franklin A. Graybill and Duane C. Boes, Introduction to the Theory of Statistics, (3rd Edition), Tata McGraw- Hill, Reprint 2007.

CO-PO & PSO Correlation

Course Name: Statistics-I												
	Program Outcomes								**PSOs**				
Cours	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1:	1		2							2	1	1	1
CO2:	1		1			1			1		1		
CO3:		1	1		1				1		2	1	1
CO4:		2	1	1						1			
CO5:	1	1				2			1		1	1	

Note: 1: Low 2: Moderate 3: High

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Programme:	**B. Sc. Hons.**	**Semester :**	**I**
Name of the Course:	**Foundation course in Mathematics**	**Course Code:**	**SOS-B-23DSA103**
Credits :	**6**	**No of Hours :**	**6 Hours/Week**
Max Marks:	**150**		

Course Description

Calculus and Linear algebra are the basic core disciplines in mathematics, and it connects subjects in pure and applied mathematics. It also has direct applications in Data Science and Artificial Intelligence. The objective of this course is to introduce the various mathematical concepts and models, and provide skills required to implement the models. Students will be able for critical evaluation of a wide range of numerical and data and develop designing skills for modelling non-deterministic problems.

Course Outcomes:

Upon completion of this course, students should be able to:

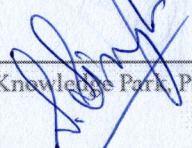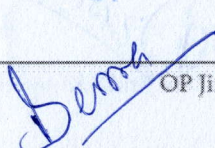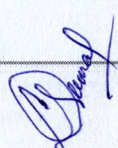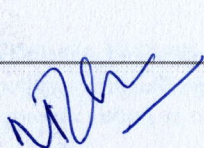| CO Number	Course Outcome
CO1	Understand and use the notion of Derivative of the function of one variable.
CO2	Determine partial derivatives of the functions of two or more variables.
CO3	Demonstrate a working knowledge of vectors and vector functions.
CO4	Apply concepts of matrix algebra for solving simultaneous linear algebraic equations. Explain the concept of complex numbers and calculate the nth roots of complex numbers and illustrate the solutions of simple Polynomial equations
CO5	Understand the introduction and application of concepts like vector spaces, inner product spaces and linear transformations.

Syllabus

Unit 1: Single Variable Calculus

Differentiation- Extrema on an Interval-Rolle's Theorem and the Mean Value Theorem-Increasing and Decreasing functions and First derivative test-Second derivative test-Maxima and Minima-Concavity. Integration-Average function value - Area between curves – Volumes of solids of revolution

Unit 2: Multivariable Calculus

Functions of two variables, limits and continuity, partial derivatives, total Differential, Jacobian and its properties, Taylor's expansion for two variables, maxima and minima, Lagrange's multiplier method, Linearization. Double Integrals over Rectangles, Double Integrals over General Regions, Double Integrals in Polar Coordinates, Applications of Double Integrals, Triple

Integrals, Change of Variables in Multiple Integrals, Beta and Gamma functions–interrelation

Unit 3: Vector Calculus

Scalar and vector valued functions, gradient, tangent plan, directional derivative, divergence and curl, scalar and vector potentials, Statement of vector identities, Simple problems, line, surface and volume integrals, Statement of Green's, Stoke's and Gauss divergence theorems, verification and evaluation of vector integrals using them.

Unit 4: Matrix Algebra and Complex Number

Algebra of matrices, elementary row operations Row reduced Echelon form, rank of a matrix Consistency of a linear system, inverse of a matrix (using elementary row operations). Eigenvalues and eigenvectors, Diagonalization of a matrix Cayley - Hamilton theorem (without proof) and its applications

Representation of complex number in Argand plane, Modulus and argument of complex number Algebraic operations, De- Moivre's theorem, nth root of complex number, Euler's formula
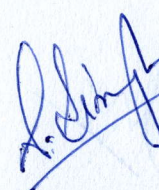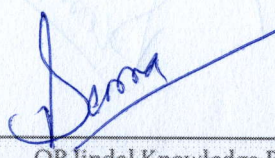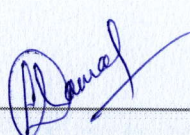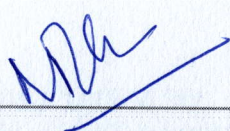
Unit 5: Linear Algebra

Vector space and subspace of vector space. Linear dependence and independence of vectors, linear span. Basis and dimension, sums and direct sums. norms, inner products, orthogonality, orthonormal basis, inner product of functions, orthogonal projections

Text Books:

1. M.P. Deisenroth, A. Aldo Faisal and C.H. Ong- Mathematics for Machine Learning- 1st ed. Cambridge University Press- 2020.
2. G. Strang- Linear Algebra and Learning from Data. - 1st ed.- Wellesley-Cambridge Press- 2019.
3. G.B. Thomas- M. D. Weir and J. Hass- Thomas Calculus- 14th ed.- Pearson Education India- 2018
4. .M. Apostol- Calculus- Vol-II- Wiley India Pvt. Ltd.- 2011.
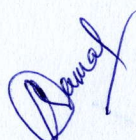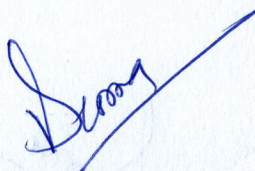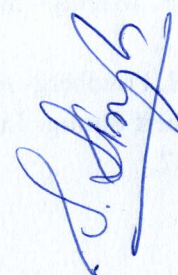
Reference Books

1. F. Ayres and E. Mendelson- Schaum's Outline of Calculus- 10th ed. USA: Mc. Graw Hill.- 2015.
2. J. Stewart- Single Variable Essential Calculus: Early Transcendentals- 2nd ed.: Belmont- USA: Brooks/Cole Cengage Learning.- 2013.
3. M. Spivak- Calculus- 4th ed.- Cambridge University Press- 2008.
4. David C. Lay- Linear Algebra and its Applications- 5th ed.-Indian Reprint- Pearson Education Asia- 2018.
5. K. P. Murthy- Machine Learning- a Probabilistic Perspective-1st ed.- MIT Press- 2012.
6. S. H. Friedberg- A. Insel- and L. Spence- Linear algebra- 4th ed.- Pearson- 2015.
7. Gilbert Strang- Linear Algebra and its Applications- 4th ed.- Thomson Brooks/Cole- 2007.

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CO-PO & PSO Correlation

Course Name : Foundation course in Mathematics												
Course Outcomes	**Program Outcomes**								**PSOs**				
	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1:	1		1		1				1	2			1
CO2:		1		1						2			
CO3:	1			1					2				1
CO4:			2		1					2		1	
CO5:		1	1		1				1	1	1		

Note: 1: Low 2: Moderate 3: High

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Programme:	B. Sc. Hons.	**Semester :**	II
Name of the Course:	R Programming	**Course Code:**	SOS-B-23DSA201
Credits :	6	**No of Hours :**	8 Hours/Week
Max Marks:	150		

Course Description:

This course is an introduce basics programming in R, and its applications in data analysis. To master the use of the R interactive environment and expanding by installing R packages.

Course Outcomes:

On successful completion of this course, students will be able to:

CO Number	Course Outcome
CO1	Use R Studio and explore the features for R programming.
CO2	Use R functions and graphics with in R programming for solving problems
CO3	Work with advanced graphics of R, import and use the data and represent the data into tables
CO4	Apply formatting on table, use Pipelines in application and use strings, factors in R
CO5	Manipulating Data Frames and make use of Dates in R application.

Syllabus:

Unit 1:

Getting started with R: R Software: Obtaining R and RStudio, First R Encounter, Getting started: R as a big calculator, Assignment, Basic operators, Help with functions and features, Quiz, A few important points on R, Working with R

R Interfaces - Using R and RStudio: R Software, Obtaining R and RStudio, The default R interface, RStudio Interface, Example Datasets in R, R Packages, Installing new R libraries, Customizing R Start-up

Objects in R: Using ls and rm to managing R Objects, Types of R objects, Attributes of R Objects, Creating and accessing objects, Modifying elements, Quick recap, Exercise

Reading and writing data to and from R: Importing and reading text files data into RStudio, Importing data using R command read.table(), Exercise, Importing text files Using scan(), Parsing each line – Readlines, Writing Data table from R, Exercise, Importaing Data from other Software, Reading data from Excel into R, Import/Export from other statistical software, From a Database Connection, Sampling and Creating simulated data, Exercise

Unit 2:

Introduction to programming and writing Functions in R: Why do we want to write functions?, Conditional statements (if, ifelse, switch), Repetitive execution: For and While loops,

The Apply Functions, Exercise, Functions for parsing text, Programming in R: More advanced, Viewing Code of functions from R packages, Exercise- Parsing Real Data - World Population Data from Wikipedia, Writing functions: more technical discussion -Scoping, Options for Running memory or CPU intensive jobs in R, Efficient R coding

Introduction to graphics in R: The R function plot(), Exercise, Customize plot with low-level plotting commands, Default parameters – par, Interacting with graphics, Saving plots, Useful Graphics Resources

Unit 3:

Advanced Graphics: Advanced plotting using Trellis; ggplots2, Lattice, Examples that Present Panels of Scatterplots using xyplot(), Simple use of xyplot

Importing Data- readr: Functions for Reading Data, File Headers, Column Types, String-based Column Type Specification, Function based Column Type Specification Parsing Time and Dates, Space-separated Columns, Functions for Writing Data

Representing Tables – tibble: Creating Tibbles, Indexing Tibbles

Unit 4:

Reformatting Tables – tidyr: Tidy Data, Gather and Spread, Complex Column Encodings, Expanding, Crossing, and Completing, Missing Values, Nesting Data

Pipelines – magrittr : The Problem with Pipelines, Pipeline Notation, Pipelines and Function Arguments, Function Composition, Other Pipe Operations

Working with Strings – stringr: Counting String Patterns, Splitting Strings, Capitalizing Strings, Wrapping, Padding, and Trimming, Detecting Substrings, Extracting Substrings, Transforming Strings

Working with Factors – forcats: Creating Factors, Concatenation, Projection, Adding Levels, Reorder Levels

Unit 5:

Manipulating Data Frames – dplyr: Selecting Columns, Filter, Sorting, Modifying Data Frames, Grouping and Summarizing, Joining Tables, Income in Fictional Countries

Working with Dates – lubridate: Time Points, Time Zones, Time Intervals
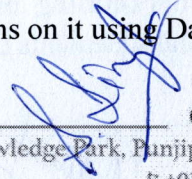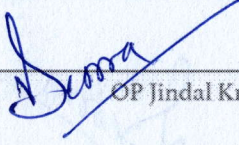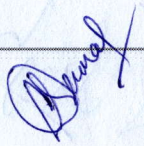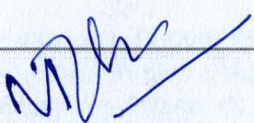
LIST OF PRACTICALS

1. Introduction to R Programming Elements
a. Write an R Program to implement expressions, assignment and decision making
b. Write an R Program to design and implement loops.
c. Write a R program to demonstrate the use of essential data structures in R [Hint: Vectors, Matrix, Arrays]

2. Using List, Data Frames and Functions in R
a. Write an R program to manage data and exhibit operations on it using List data structure
b. Write an R program to manage data and exhibit operations on it using Data

Frames

c. Write an R program to demonstrate the use of :

i. user-defined functions

ii. built-in numeric function, character functions etc.

3. Implementing Strings in R

a. Write an R program to store and access string in R objects(vectors, matrix, arrays, data frames, and lists)

b. Write an R program to demonstrate use of various string manipulation functions.
[Hint: paste(), print(), noquote(),format(), cat(), toString(), sprint()]

4. Performing Statistics with R-I

a. Write an R program to apply built-in statistical functions. [Hint: mean, median, standard deviation and others]

b. Write an R program to demonstrate Linear and Multiple Regression analysis.

5. Performing Statistics with R-II

a. Write an R program to implement

i. Normal Distribution. [Hint: dnorm(), pnorm(), qnorm(), rnorm()]

ii. Binomial Distribution: [Hint: dbinom(), pbinom(),qbinom(),rbinom()]

b. Write an R program to perform time-series analysis for the given data.

6. Data Visualization and Analysis

a. Write an R program to learn about Tabulation and related concepts [Hint: Contingency Tables, Selection of Parts, Conversion, Complex Tables, Cross Tabulation]

b. Write an R program to demonstrate various ways of performing Graphical analysis.[Hint: Plots, Special Plots, Storing Graphics]

7. Object Oriented Programming in R

a. Write an R program to demonstrate OOP concepts, the construction and use of S3 and S4 classes

b. Write an R program to define reference class and operations on them.
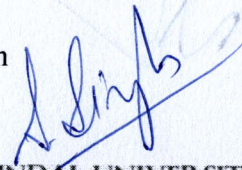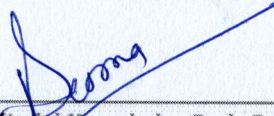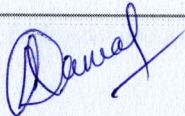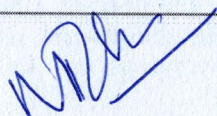
8. Data Interfaces in R

a. Write an R program to demonstrate data interface with CSV files [Hint: creating data for CSV, analyzing, writing CSV files]

b. Write an R program to work with spreadsheet (Excel) programs. [Hint: installing, loading, verifying, creating data for xlsx file]

c. Write an R program to manage data using XML files. [Develop data interface for maintaining Employee Information]

d. Write an R program to demonstrate working with RMySQL Package

9. Handling Errors in R

a. Write an R program to demonstrate various error messages in R Programming

b. Write an R program to implement Error Handling in R [Hint:
warning(),stop(),try(), tryCatch(), CallingHandlers()]

10. Measuring Performance

a. Write R program to measure the performance with the help of bult-in function like mocrobechmark().

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Text Books

1. Aedin Culhane, Introduction to Programming and Statistical Modelling in, HARVARD SCHOOL 1st 2013
2. Thomas Mailund, R Data Science Quick Reference, Apress 1st 2019
3. Tilman M. Davies, THE BOOK OF R, No starch press 1st 2016
4. Nina Zumel John, Practical Data Science with R, MOUNT MANNING 2014
5. Thomas Mailund, Beginning Data Science in R, Apress 2017
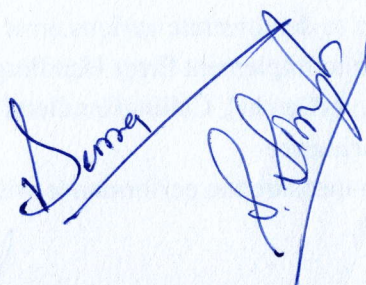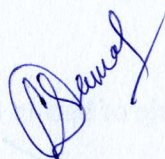
Reference Books

1. Crawley, M.J. (2015): Statistics: An Introduction Using R, 2nd Edition. Wiley.
2. Crawley, M.J. (2012): The R Book, 2nd Edition. Wiley.

CO-PO & PSO Correlation

Course Name:	R Programming												
	Program Outcomes								**PSOs**				
Course	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1:	1	1				1			1	1	1	1	1
CO2:				2					1	1	.1		
CO3:		1	1			1			1		1	2	1
CO4:	1			1	2					2	2		
CO5:	2		1		1				1			1	

Note: 1: Low 2: Moderate 3: High.

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Programme:	**B. Sc. Hons.**	**Semester :**	**II**
Name of the Course:	**Database Management System**	**Course Code:**	**SOS-B-23DSA202**
Credits :	**6**	**No of Hours :**	**8 Hours/Week**
Max Marks:	**150**		

Course Description

This course offers lecture, laboratory, and online interaction to provide a foundation in data management concepts and database systems. It includes representing information with the relational database model, manipulating data with an interactive query language (SQL). It also includes database applications, security, and integrity and privacy issues.

COURSE OUTCOMES:

At the end of this course, the student will be able to:

CO1	understand the fundamental concepts of database and data model.
CO2	understand relational algebra and write SQL queries
CO3	understand normal forms
CO4	Understand transaction management.
CO5	Understand different file organization.

Syllabus

Unit-I:

Database approach v/s Traditional file system, Data models, Schemas and instances, Data independence, Data models, ER data model: Entitles and attributes, Entity types, Concept of Generalization, Aggregation and Specialization. transforming ER diagram into the tables.

Unit-II:

Introduction to the Relational Model, Integrity Constraints, Querying on relational database, Relational Algebra and Relational calculus. SQL Queries, Nested subqueries, Aggregate functions, Set operations, Joins, SQL Triggers and Active Data bases.
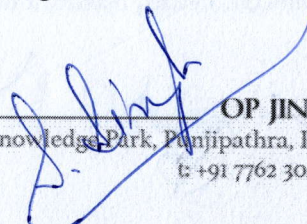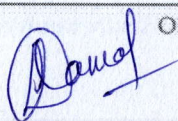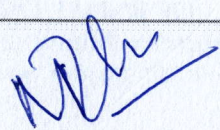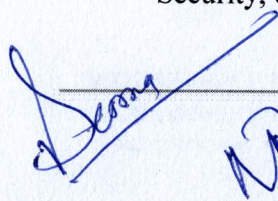
Unit-III:

Normal forms, Functional dependency, Decomposition, Dependency preservation and lossless join, multivalued dependencies, Query Optimization.

Unit-IV:

Transaction management: ACID properties, Serializability and concurrency control, Lock based concurrency control (2PL, Deadlocks), Time stamping methods, optimistic methods, database recovery management.

Unit-V:

File Organization and Indexing, Clusters, Indexes, Hashing and Tree Base Indexing. Database Security, current trends in Databases.

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Introduction to Database System Lab

1) Create a database having two tables with the specified fields, to computerize a library system of a Delhi University College.

Library Books (Accession number, Title, Author, Department, Purchase Date, Price)

Issued Books (Accession number, Borrower)

    a) Identify primary and foreign keys. Create the tables and insert at least 5 records in each table.

    b) Delete the record of book titled "Database System Concepts".

    c) Change the Department of the book titled "Discrete Maths" to "CS".

    d) List all books that belong to "CS" department.

    e) List all books that belong to "CS" department and are written by author "Navathe".

    f) List all computer (Department="CS") that have been issued.

    g) List all books which have a price less than 500 or purchased between "01/01/2014" and "01/01/2021".

2) Create a database having three tables to store the details of students of Computer Department in your college.
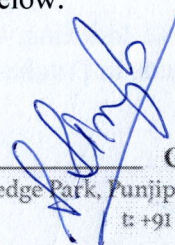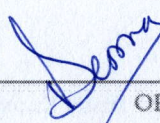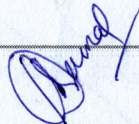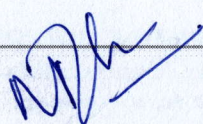
Personal information about Student (College roll number, Name of student, Date of birth, Address, Marks(rounded off to whole number) in percentage at 10 + 2, Phone number)

Paper Details (Paper code, Name of the Paper)

Student's Academic and Attendance details (College roll number, Paper code, Attendance, Marks in home examination).

    a) Identify primary and foreign keys. Create the tables and insert at least 5 records in each table.

    b) Design a query that will return the records (from the second table) along with the name of student from the first table, related to students who have more than 75% attendance and more than 60% marks in paper 2.

    c) List all students who live in "Delhi" and have marks greater than 60 in paper 1.

    d) Find the total attendance and total marks obtained by each student.

    e) List the name of student who has got the highest marks in paper 2.

3) Create the following tables and answer the queries given below:

Customer (CustID, email, Name, Phone, ReferrerID)

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Bicycle (BicycleID, DatePurchased, Color, CustID, ModelNo)

BicycleModel (ModelNo, Manufacturer, Style)

Service (StartDate, BicycleID, EndDate)

    a) Identify primary and foreign keys. Create the tables and insert at least 5 records in each table.

    b) List all the customers who have the bicycles manufactured by manufacturer "Honda".

    c) List the bicycles purchased by the customers who have been referred by customer "C1".

    d) List the manufacturer of red colored bicycles.

    e) List the models of the bicycles given for service.

4) Create the following tables, enter at least 5 records in each table and answer the queries given below.

EMPLOYEE (Person_Name, Street, City)

WORKS (Person_Name, Company_Name, Salary)

COMPANY (Company_Name, City)

MANAGES (Person_Name, Manager_Name)

    a) Identify primary and foreign keys.

    b) Alter table employee, add a column "email" of type varchar(20).

    c) Find the name of all managers who work for both Samba Bank and NCB Bank.

    d) Find the names, street address and cities of residence and salary of all employees who work for "Samba Bank" and earn more than $10,000.

    e) Find the names of all employees who live in the same city as the company for which they work.

    f) Find the highest salary, lowest salary and average salary paid by each company.

    g) Find the sum of salary and number of employees in each company.

    h) Find the name of the company that pays highest salary.

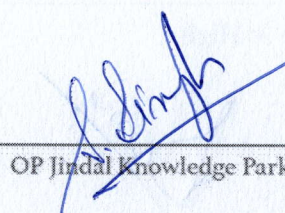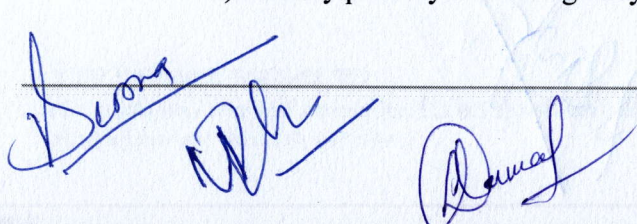5) Create the following tables, enter at least 5 records in each table and answer the queries given below.

Suppliers (SNo, Sname, Status, SCity)

Parts (PNo, Pname, Colour, Weight, City)

Project (JNo, Jname, Jcity)

Shipment (Sno, Pno, Jno, Qunatity)

    a) Identify primary and foreign keys.

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b) Get supplier numbers for suppliers in Paris with status>20.

c) Get suppliers details for suppliers who supply part P2. Display the supplier list in increasing order of supplier numbers.

d) Get suppliers names for suppliers who do not supply part P2.

e) For each shipment get full shipment details, including total shipment weights.

f) Get all the shipments where the quantity is in the range 300 to 750 inclusive.

g) Get part nos. for parts that either weigh more than 16 pounds or are supplied by suppliers S2, or both.

h) Get the names of cities that store more than five red parts.

i) Get full details of parts supplied by a supplier in London.

j) Get part numbers for part supplied by a supplier in London to a project in London.

k) Get the total number of project supplied by a supplier (say, S1).

l) Get the total quantity of a part (say, P1) supplied by a supplier (say, S1).

Text Books:
1. Silberschatz, Korth, "Data base System Concepts", McGraw Hill, 6th edition.
2. Elmasri Navathe, "Fundamentals of Database Systems", Pearson Education.
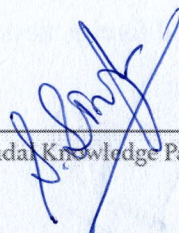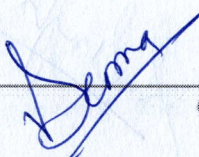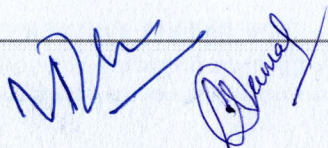3. C J Date, "An Introduction to Database Systems", 8th Edition

Reference Books:
1. Rini Chakrabarti, Shilbhadra Dasgupta, "Advanced Database Management System", Wiley India Pvt. Limited
2. Peter Rob & Carlos Coronel, "Data base Systems design, Implementation and Management", 7th Edition.
3. Raghurama Krishnan & Johannes Gehrke, "Data base Management Systems", TATA McGraw Hill, 3rd Edition.

CO-PO & PSO Correlation

Course Name : Database Management System													
Course Outcomes	**Program Outcomes**								**PSOs**				
	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1:	1		1						1		2	1	1
CO2:		1		1					2		2	1	
CO3:	1			1					1		2	1	1
CO4:			2		1				1	2		1	
CO5:		1			1				1		2	1	

Note: 1: Low 2: Moderate 3: High

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Programme:	B. Sc. Hons.	**Semester :**	II
Name of the Course:	Differential Equations, Complex Variable and Numerical Methods	**Course Code:**	SOS-B-23DSA203
Credits :	6	**No of Hours :**	8 Hours/Week
Max Marks:	150		

Course Description:

This is an introductory course in to familiarize 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 coefficient. To provide the student with numerical methods of solving the non-linear equations, interpolation, differentiation, and integration.

Course Outcomes:

On successful completion of this course, students will be able to:

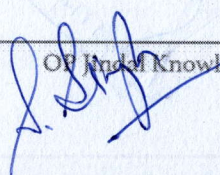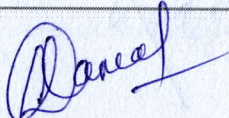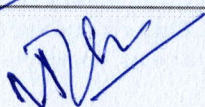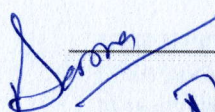| CO Number	Course Outcome
CO1	Explain the classification of ordinary differential equations according to order and linearity
CO2	Solve second order and higher order linear differential equations.
CO3	Describe the solution of complex differentiation, and Complex Integration.
CO4	Solve the algebraic or transcendental equations and linear system of equations using an appropriation method.
CO5	Evaluate the differentiation and Integration numerically and solve a first order differential equation

Syllabus

Unit 1:

Initial Value Problem, Boundary Value Problem, Separable Equations, Homogeneous equation, Exact equation, Linear equation, Bernoulli's equations, Modelling with Differential Equations, Models for Population Growth, logistic growth.

Unit 2:

Higher order Homogenous linear differential equation with constant coefficients, method of variation of parameters. Cauchy-Euler equation, Legendre's Linear equation, Simultaneous differential Equation, Application of 2nd order differential equation.

Unit 3:

Complex Differentiation, Cauchy-Riemann equations, analytic functions, harmonic

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functions, finding harmonic conjugate; elementary analytic functions (exponential, trigonometric, logarithm) and their properties; Complex Integration, Cauchy Integral formula (without proof), Taylor's series, zeros of analytic functions, singularities, Laurent's series; Residues, Cauchy Residue theorem (without proof), Evaluation of definite integral in a unit circle, semicircle and on a real line.

Unit 4: Numerical Solution of algebraic and transcendental Equations, Bisection Method, Regula Falsi Method, Newton's Method, Secant Method, Numerical Solution of Linear Systems, Gauss Elimination Method, LU Factorization Methods, Jacobi and Gauss Seidel Method.

Unit 5: Polynomial Interpolation, Numerical Differentiation for equal and unequal interval differences, Numerical Integration: Newton–Cotes Formulas, Trapezoidal, simpson's 1/3rd and 3/8th formula, Numerical Solution of Initial-Value Problems by Euler's Method, Modified Euler Method and Runge–Kutta Methods.

List of Programs

List of Practical (R/Python/Scilab/Matlab):
1 Write a program
- a Bisection Method
- b Regula Falsi Method
- c Newton's Method
- d Secant Method

2 Write a program
- a Gauss Elimination Method
- b LU Factorization Methods
- c Jacobi Method
- d Gauss Seidel Method

3 Write a program
- a Newton Forward Interpolation formula
- b Newton Backward Interpolation formula
- c Lagrange Interpolation formula
- d Newton divided difference Interpolation formula
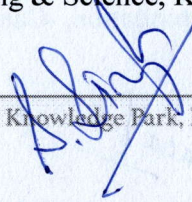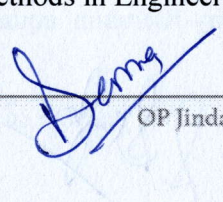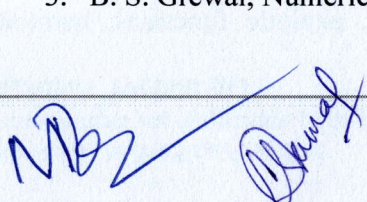
4 Write a program
- a Trapezoidal Rule
- b Simpson's 1/3rd rule
- c Simpson's 3/8th Rule

5 Write a program
- a Euler's Method
- b Modified Euler Method
- b Runge–Kutta Methods

Text Books

1. M D Raisinghania, Differential Equation. S Chand Publication
2. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 36th Edition, 2010& Sons- New Delhi- 2020.
3. B. S. Grewal, Numerical methods in Engineering & Science, Khanna Publishers, 2013.

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4. Jain, Iyengar, Jain, Numerical methods for Scientific and Engineering Computation, New Age International Publishers, 2004.

Reference Books

1. EndreSuli, David F. Mayers, An Introduction to Numerical Analysis, Cambridge University Press, 2003.
2. C. F. Gerald, Applied Numerical Analysis, Pearson Education, 2009.
3. R. S. Gupta, Elements of Numerical Analysis, Macmillan India Ltd, 2009.
4. Erwin kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
5. W. E. Boyce and R. C. DiPrima, Elementary Differential Equations and Boundary Value Problems, 9th Edn., Wiley India, 2009.

CO-PO & PSO Correlation

Course Name : Differential Equations, Complex Variable and Numerical Methods												
Course Outcomes	**Program Outcomes**								**PSOs**			
	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1:	1		1		1				1	1	1		1
CO2:		1		1							2	1	
CO3:	1			1					1		1		1
CO4:			2		1					2	1	1	
CO5:		1			1				1		1		

Note: 1: Low 2: Moderate 3: High