

Courses Structure

B. Sc. (Data Science & Data Analytics) Programme

B. Sc. (Data Science & Data Analytics) is a 3-year undergraduate course designed to provide theoretical and practical knowledge of Data Science & Data Analytics along-with core subjects in the field of computer science and information technology. In order to master the skills, a learner should have strong mathematical, statistical and computational skills. The course aims to cover all the important subjects required for the same. It also exposes few areas of research and aims to imbibe basic managerial skills.

Course Highlights

Name of the Course	B.Sc. (Data Science & Data Analytics)
Level	Undergraduate
Duration	3 Years
Minimum Academic Requirement	10 + 2
Minimum Aggregate Score Requirement	50% or more in Mathematics and also overall
Stream Requirement	XII Science / Commerce / Arts with Mathematics subject (Merit List on Mathematics marks)
Course mode	Full - Time
Exam Type	Semester

Objectives of the Course

- To get an understanding about the amount of data needed today for business decisions is increasing, which is covered in Machine Learning, Business Intelligence, and Big Data Analytics.
- To develop positive attitude and skills which enable them to become multi-facet personalities.
- Prepare professionals conversant with current and advanced technological tools to carry out investigation, analysis and synthesis by developing various computer-oriented applications and solutions.
- To make them aware of effective machine learning and Artificial Intelligence-based data analytics and inference required for Industrial Application.
- To inculcate a passion for lifelong learning by introducing principles of group dynamics, public policies, environmental and societal context.

Outcomes

After completion of the course, students would be able to:

- Obtain data from a variety of sources. Know the principles of data and data sharing.
- Understand and be able to apply the basic tools for data cleaning and manipulation.
- Understand the concise, precise and rigorous nature of Data Science.
- Develop the skill to pleasant exposition for successful presentation for any career interview with confidence.
- Work as a team player striving for self-excellence and communicate effectively with an elite audience.
- Apply principles of data science and analytics in various domains

First Year (Semester I)

Assuming 15 weeks of teaching and Practical Batch Size(30)

Title of the Course	Number of Lectures/ Practicals	(Theory) per week	(Practical) per week	Credits
Introduction to Operating System and Networking Concepts	60	4	-	3
Introduction to Programming using Python	60	4	-	3
Mathematics for Data Science	60	4	-	3
Descriptive Statistics	60	4	-	3
Web Technologies	60	4	-	3
Practical of Introduction to Operating System and Networking Concepts	45	-	3	1
Practical of Introduction to Programming using Python	45	-	3	1
Practical of Mathematics for Data Science	45	-	3	1
Practical of Descriptive Statistics	45	-	3	1
Practical of Web Technologies	45	-	3	1
Total				20

First Year (Semester II)

Title of the Course	Number of Lectures/ Practicals	(Theory) per week	(Practical) per week	Credits
DBMS & NoSQL	60	4	-	3
Advanced Python	60	4	-	3
Research Methodology	60	4	-	3

Probability and Inferential Statistics	60	4	-	3
Soft Skill	60	4	-	3
Practical of DBMS & NoSQL	45	-	3	1
Practical of Advanced Python	45	-	3	1
Practical of Research Methodology	45	-	3	1
Practical of Probability and Inferential Statistics	45	-	3	1
Practical of Soft Skill	45	-	3	1
Total				20

Second Year (Semester III)

Title of the Course	Number of Lectures/ Practicals	(Theory) per week	(Practical) per week	Credits
Algorithms and Data Structures	60	4	-	3
Introduction to Data Science	60	4	-	3
Advanced Statistical Methods	60	4	-	3
Data Warehousing and Data Mining	60	4	-	3
IoT	60	4	-	3
Practical of Algorithms and Data Structures	45	-	3	1
Practical of Introduction to Data Science	45	-	3	1
Practical of Advanced Statistical Methods	45	-	3	1
Practical of Data Warehousing and Data Mining	45	-	3	1
Practical of IoT	45	-	3	1

Total				20
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Second Year (Semester IV)

Title of the Course	Number of Lectures/ Practicals	(Theory) per week	(Practical) per week	Credits
Object Oriented Programming using Java	60	4	-	3
AI & Machine Learning	60	4	-	3
Software Engineering	60	4	-	3
Cloud Computing	60	4	-	3
Mobile Programming	60	4	-	3
Practical of Object Oriented Programming using Java	45	-	3	1
Practical of AI & Machine Learning	45	-	3	1
Practical of Software Engineering	45	-	3	1
Practical of Cloud Computing	45	-	3	1
Practical of Mobile Programming	45	-	3	1
Total				20

Third Year (Semester V)

Title of the Course	Number of Lectures/ Practicals	(Theory) per week	(Practical) per week	Credits
Data Analytics & Visualization	60	4	-	3
Cyber Security	60	4	-	3
Natural Language Processing	60	4	-	3
Big Data & BigData Technologie	60	4	-	3

Principles of Management and Entrepreneurship	60	4	-	3
Practical of Data Analytics & Visualization	45	-	3	1
Practical of Cyber Security	45	-	3	1
Practical of Natural Language Processing	45	-	3	1
Practical of Big Data & BigData Technologie	45	-	3	1
Project Practical	45	-	3	1
Total				20

Third Year (Semester VI)

Title of the Course	Number of Lectures/ Practicals	(Theory) per week	(Practical) per week	Credits
Deep Learning and Neural Networks	60	4	-	3
Business Intelligence and Web Analytics	60	4	-	3
Bioinformatics	60	4	-	3
Blockchain	60	4	-	3
Green Computing	60	4	-	3
Practical of Deep Learning and Neural Networks	45	-	3	1
Practical of Digital Marketing and Web Intelligence	45	-	3	1
Practical of Bioinformatics	45	-	3	1
Practical of Blockchain	45	-	3	1
Project Practical	45	-	3	1
Total				20

Vivekanand Education Society's
College of Arts, Science & Commerce
(Autonomous)



Proposed Syllabus

For the

Program: F.Y.B.Sc. Sem - I & II

CBCS Course:

BSc DATA SCIENCE & DATA ANALYTICS

(Choice Based and Credit System with effect
from the academic year 2022-23)

Sr. No.	Heading	Particulars
1.	Title of the Course	F.Y.B.Sc. Sem. I & II (Data Science & Data Analytics)
2.	Eligibility for Admission	50 % Overall + 50% in Mathematics (XIIth Science / Commerce / Arts Merit List on Mathematics marks)
3.	Passing Marks	40%
4.	Ordinances / Regulations (if, any)	-
5.	Number of years / Semesters	Three years – Six Semesters
6.	Level	P.G./ U.G. /Diploma / Certificate (Strike out which is not applicable)
7.	Pattern	Yearly / Semester, Choice Based (Strike out which is not applicable)
8.	Status	New / Revised
9.	To be implemented from Academic year	From the Academic Year <u>2022 – 2023</u>

Preamble

B. Sc. (Data Science & Data Analytics) is a 3-year undergraduate course designed to provide theoretical and practical knowledge of Data Science & Data Analytics along-with core subjects in the field of computer science and information technology. In order to master the skills, a learner should have strong mathematical, statistical and computational skills. The course aims to cover all the important subjects required for the same. It also exposes few areas of research and aims to imbibe basic managerial skills.

Programme Structure for B.Sc. Computer Science

Level	Undergraduate
Duration	3 Years
Minimum Academic Requirement	10 + 2
Minimum Aggregate Score Requirement	50 % Overall + 50% in Mathematics (Merit List on Mathematics marks)
Stream Requirement	XII Science / Commerce / Arts with Mathematics subject
Course mode	Full - Time

Objectives of the Course

- To get an understanding about the amount of data needed today for business decisions is increasing, which is covered in Machine Learning, Business Intelligence, and Big Data Analytics.
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After completion of the course, students would be able to:

- Obtain data from a variety of sources. Know the principles of data and data sharing.
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Academic year 2022-2023

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Assuming 15 weeks of teaching and Practical Batch Size(30)

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Total				20

First Year (Semester II)

Title of the Course	Number of Lectures/Practs	(Theory) per week	(Practical) per week	Credits
DBMS & NoSQL	60	4	-	3
Advanced Python	60	4	-	3
Research Methodology	60	4	-	3
Probability and Inferential Statistics	60	4	-	3
Soft Skill	60	4	-	3
Practical of DBMS & NoSQL	45	-	3	1
Practical of Advanced Python	45	-	3	1
Practical of Research Methodology	45	-	3	1

Practical of Probability and Inferential Statistics	45	-	3	1
Practical of Soft Skill	45	-	3	1
Total				20

FYBSc

Semester I

Course Code	Course Title	Credits	Lectures / Week
VESUSDS 101	Introduction to Operating System and Networking Concepts	3	4
<p>About the course: This syllabus will help to train students in fundamental skills and build-up sustainable interest in Linux Operating System. It will improve the necessary knowledge base to understand Linux Operating System and its practical implementation, it will also help to develop Linux based solutions for real life problems.</p>			
<p>Course Objectives:</p> <ul style="list-style-type: none"> ● To learn basic concepts of Linux in terms of operating system. ● To learn use of various shell commands with regular expressions. ● To set Linux Environment variables and learn setting file permissions to maintain Linux security implementation. ● To learn various editors available in Linux OS. ● To learn shell scripting. 			
<p>Learning Outcomes: After successful completion of this course, students would be able to</p> <ul style="list-style-type: none"> ● Work with Linux file system structure, Linux Environment. ● Handle shell commands for scripting, with features of regular expressions, redirections. ● Implement file security permissions. ● Work with vi, sed and awk editors for shell scripting using various control structures 			
Unit	Topic	No. of lectures	
I	<p>Linux operating system and Basics : History, GNU Info and Utilities, Various Linux Distributions, The Unix/Linux architecture, Features of Unix/Linux, Starting the shell, Shell prompt, Command structure, File Systems and Directory Structure, man pages, more documentation pages</p> <p>Basic Bash shell commands: General purpose utility Commands, basic commands, Various file types, attributes and File handling Commands, Handling Ordinary Files. More file attributes</p> <p>Advanced Bash shell commands: Simple Filters, Filters using regular expressions.</p>	12	

	The Linux environment variable: Setting, Locating and removing environment variables like PATH etc, Default shell environment variables, Using command aliases.	
II	Understanding Linux file permission: Linux security, Using Linux groups, Decoding file permissions, Changing security setting, Sharing files. Working with Editors: awk, sed and Introduction to vi Basic script building: Using multiple commands, Creating script files, Displaying messages, Using variables, Redirecting Input and Output, Pipes performing math, Exiting the script. Using structured commands: Working with if-then, if-then-else and nested if statements, test command, Compound condition testing, case command.	12
III	Script and Process control : Handling signals, Running scripts in background mode, Running scripts without a console, Job control, Job scheduling commands: ps, nice, renice, at, batch, cron table, Running the script at boot Linux Security: Understanding Linux Security, uses of root, sudo command, working with passwords, Understanding ssh. Networking: TCP/IP Basics, TCP/IP Model, Resolving IP addresses, Applications, ping, telnet, ftp, DNS	12
IV	Introduction to Networking: Introduction to data communication, Components, Data Representation, Data Flow, Networks, Network Criteria, Physical Structures, Network types, Local Area Network, Wide Area Network, Switching, The Internet, Accessing the Internet, standards and administration Internet Standards.	12
V	Introduction to Network Models : Network Models, Protocol layering, Scenarios, Principles of Protocol Layering, Logical Connections, TCP/IP Basics, TCP/IP Model, Resolving IP addresses, OSI Model, Applications, ping, telnet, ftp, DNS	12
<p>Textbooks:</p> <ol style="list-style-type: none"> 1. “Linux Command line and Shell Scripting Bible”, Richard Blum, Wiley India. 2. “Unix: Concepts and Applications”, Sumitabha Das, 4th Edition, McGraw Hill. 3. “Official Ubuntu Book”, Matthew Helmke& Elizabeth K. Joseph with Jose Antonio Rey and Philips Ballew, 8th Ed. <p>Additional References:</p> <ol style="list-style-type: none"> 1. “Linux Administration: A Beginner's Guide”, Fifth Edition, Wale Soyinka, Tata McGraw-Hill, 2008. \ 2. “Linux: Complete Reference”, Richard Petersen, 6th Edition, Tata McGraw-Hill 3. “Beginning Linux Programming”, Neil Mathew, 4th Edition, Wiley Publishing, 2008 		

Course Code	Course Title	Credits	Practical/ Tutorials Per Week
VESUSDS P101	Practical of Operating System and Networking Concepts	1	3
1.	Installation of Ubuntu Linux operating system. a) Booting and Installing from (USB/DVD) b) Using Ubuntu Software center / Using Synaptic c) Explore useful software packages.		
2.	File System Commands: touch, help, man, more, less, pwd, cd, mkdir, rmdir, ls, find, ls, etc		
3.	File handling Commands: cat, cp, rm, mv, more, file, wc, od, cmp, diff, comm, gzip and gunzip, zip and unzip, tar, ln, umask,, chmod, chgrp, chown, etc		
4.	General purpose utility Commands: cal, date, echo, man, printf, passwd, script, who, uname, tty, stty, etc		
5.	Simple Filters and I/O redirection: head, tail, cut paste, sort, grep family, tee, uniq, tr, etc.		
6.	Editors: vi, sed, awk		
7.	Shell scripting I: Defining variables, reading user input, exit and exit status commands, , expr, test, [], if conditional, logical operators		
8.	Working and Managing with processes- sh, ps, kill, nice, at and batch etc.		
9.	Networking Commands: who, whoami, ping, telnet, ftp, ssh, etc		
10.	Problem solving with IPv4, which will include the concept of Classful addressing.		

Course Code	Course Title	Credits	Lectures / Week
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VESUSDS 102	Introduction to Programming using Python	3	4
<p>About the course: This course is aimed at introducing one of the fastest growing programming languages of the current time and enables learners to understand the fundamentals of programming with Python. Learners will be able to write programs to solve real-world problems, and produce quality code. It will help to develop strong skills of programming for implementing applications for emerging fields including data science and machine learning.</p>			
<p>Course Objectives:</p> <ul style="list-style-type: none"> ● To learn how to design and program Python applications. ● To explore the innards of Python Programming and understand components of Python Program ● To define the structure and components of a Python program. ● To learn how to write loops and decision statements inPython ● To learn about inbuilt input/output operations and compound data types in Python 			
<p>Learning Outcomes: After successful completion of this course, students would be able to</p> <ul style="list-style-type: none"> ● After successful completion of this course, students would be able to: ● Ability to store, manipulate and access data in Python ● Ability to implement basic Input / Output operations in Python ● Ability to define the structure and components of a Python program. ● Ability to learn how to write loops and decision statements inPython. ● Ability to learn how to write functions and pass arguments inPython. ● Ability to create and use Compound data types in Python 			
Unit	Topic		
I	<p>Algorithms and Programming Paradigms</p> <p>Overview of different programming paradigms e.g. imperative, object oriented, functional, logic and concurrent programming. Depiction of algorithms and pseudocodes and working on various problem statements using such tools.</p> <p>Overview of Python: History & Versions, Features of Python, Execution of Python Program, Flavors of Python, Installing Python, Writing and Executing First Python Program, Getting Help, IDLE</p>		12

<p align="center">II</p>	<p>Data Types, Variables and Other Basic Elements: Comments, Docstrings, Data types- Numeric Data type, Compound Data Type, Boolean Data type, Basic Elements of Python,</p> <p>Variables, Operators: Arithmetic operators, Assignment operators, Input and Output Operations: Input Function, Output Statements, The print() function, The print(“string”) function, The print(variables list) function, The print(object) function, The print(formatted string) function, Command Line Arguments. Unary minus operator, Relational operators, Logical operators, Bitwise operators, Membership operators, Identity operators, Precedence of Operators, Associativity of Operators,</p> <p>Conditional Statements: The if statement, The if ... else Statement, The „if ..elif ... else Statement.</p>	<p align="center">12</p>
<p align="center">III</p>	<p>Iterative Statements: Loop Statement- while loop, for loop, Infinite loop, Nested loop, The else suite, break statement, continue statement, pass statement.</p> <p>Modules: Introduction to Modules in Python, Use of various smart editors like Jupyter Notebook for using Python and introduction to pip.</p> <p>Arrays: Creating Arrays, Indexing and Slicing of Arrays, Basic Array Operations, Arrays Processing, Mathematical Operations on Array, Aliasing Arrays, Slicing and Indexing in NumPy Arrays, Basic slicing, Advanced Indexing, Dimensions of Arrays, Attributes of an Array, The ndim Attribute, The shape Attribute, The size Attribute, The itemsize Attribute</p> <p>Date and time in python: Date and time now, combining date and time, formatting dates and times, finding durations using “time delta”, comparing two dates, sorting dates, knowing the time taken by a program, calendar module</p>	<p align="center">12</p>
<p align="center">IV</p>	<p>Python Collections -</p> <p>Strings: Creating Strings, Functions of Strings, Working with Strings, Length of a String, Indexing and Slicing, Repeating and Concatenating Strings, Checking Membership, Comparing Strings, Removing Spaces, Finding Substrings, Counting Substrings, Immutability, Splitting and Joining Strings, Changing Case, Checking Starting and Ending of a String, Sorting Strings, Searching in the Strings, Testing Methods, Formatting Strings, Finding the Number of Characters and Words, Inserting Substrings into a String</p> <p>List and Tuples: Lists, List Functions and Methods, List Operations, List Slices, Nested Lists, Tuples, Functions in Tuple</p>	<p align="center">12</p>

V	<p>Dictionaries: Creating a Dictionary, Operators in Dictionary, Dictionary Methods, Using for Loop with Dictionaries, Operations on Dictionaries, Converting Lists into Dictionary, Converting Strings into Dictionary, Passing Dictionaries to Functions, Sorting the Elements of a Dictionary using Lambda, Ordered Dictionaries</p> <p>User Defined Functions: Function definition and call, Returning Results, Returning Multiple Values from a Function, Built-in Functions, Difference between a Function and a Method, Pass Value by Object Reference, Parameters and Arguments, Formal and Actual Arguments, Positional Arguments, Keyword Arguments, Default Arguments, Arbitrary Arguments, Functions, Anonymous or Lambda Functions, Using Lambda with the filter() Function, Using Lambda with the map() Function, Using Lambda with the reduce() Function</p>	12
<p>Textbooks:</p> <ol style="list-style-type: none"> 1. Let Us Python, Yashwant. B. Kanetkar, BPB Publication, 2019. 2. Practical Programming: An Introduction to Computer Science Using Python 3, Paul Gries , Jennifer Campbell, Jason Montojo, Pragmatic Bookshelf, 2nd Edition 3. Beginning Python: From Novice to Professional, Magnus Lie Hetland, Apress, 2017 <p>Additional References:</p> <ol style="list-style-type: none"> 1) Python: The Complete Reference, Martin C. Brown, McGraw Hill, 2018 2) Programming in Python, Mark Summerfield, Pearson Education, 2nd Ed, 2018 3) Python Programming: Using Problem Solving Approach, Reema Thareja, Oxford University Press, 2017 		

Course Code	Course Title	Credits	Practical/ Tutorials Per Week
VESUSDSP 102	Practical of Programming using Python	1	3
1	Write a program to design and develop python program to implement various control statement using suitable examples		
2	Write a Python program to demonstrate the precedence and associativity of operators.		

3	Write suitable Python program to implement recursion for problems such as Fibonacci series, Factorial, Prime number etc
4	Write a python program to create and manipulate arrays in Python. Also demonstrate use of slicing and indexing for accessing elements from the array.
5	Write a python program to execute the difference in dates and execute various date manipulations.
6	Write a program to implement a list in Python for suitable problems. Demonstrate various operations on it.
7	Write a program to implement tuples in Python for suitable problems. Demonstrate various operations on it
8	Write a program to implement a dictionary in Python for suitable problems. Demonstrate various operations on it
9	Write a program in Python to define and call functions for suitable problems.
10	Write Python program to implement and use lambda function in python

Course Code	Course Title	Credits	Lectures / Week
VESUS DS103	Mathematics for Data Science	3	4
<p>About the Course: The course covers the important subjects under Mathematics - Calculus and Linear Algebra that are highly useful for the students doing Data Science.</p>			
<p>Course Objectives:</p> <ul style="list-style-type: none"> • The primary objective of this course is to introduce the basic tools of Calculus which are helpful in understanding their applications to the real world problems. • The course is designed to have a grasp of important concepts of Calculus in a scientific way. • It covers topics from as basic as definition of functions to partial derivatives of functions in a gradual and logical way. • The learner is expected to solve as many examples as possible to get complete clarity and understanding of the topics covered. • To offer the learner the relevant linear algebra concepts through computer science applications. 			
<p>Learning Outcomes: After successful completion of this course, learners would be able to:</p> <ul style="list-style-type: none"> • Develop mathematical skills and enhance the thinking power of learners. 			

	<ul style="list-style-type: none"> • Understand mathematical concepts like limit, continuity, derivative, integration of functions, partial derivatives. • Appreciate real world applications which use the learned concepts. • Skill to formulate a problem through Mathematical modeling and simulation. • Appreciate the relevance of linear algebra in the field of computer science. • Understand the concepts through program implementation • Instill computational thinking while learning linear algebra. 	
Unit-I	<p>DERIVATIVES AND ITS APPLICATIONS: Review of Basic Concepts: Functions, limit of a function, continuity of a function, derivative function. Derivative In Graphing And Applications: Increase, Decrease, Concavity, Relative Extreme; Graphing Polynomials, Rational Functions, Cusps and Vertical Tangents. Absolute Maxima and Minima, Applied Maximum and Minimum Problems, Newton’s Method.</p>	12
Unit-II	<p>INTEGRATION AND ITS APPLICATIONS: Integration: An Overview of the Area Problem, Indefinite Integral, Definition of Area as a Limit; Sigma Notation, Definite Integral, Evaluating Definite Integrals by Substitution, Numerical Integration: Simpson’s Rule. Applications of Integration: Area between two curves, Length of a plane curve. Mathematical Modeling with Differential Equations: Modeling with Differential Equations, Separation of Variables, Slope Fields, Euler’s Method, First-Order Differential Equations and Applications.</p>	12
Unit-III	<p>PARTIAL DERIVATIVES AND ITS APPLICATIONS: Functions of Several Variables: Functions of two or more variables, Limits and Continuity of functions of two or three variables. Partial Derivatives: Partial Derivatives, Differentiability, Differentials, and Local Linearity, Chain Rule, Implicit Differentiation, Directional Derivatives and Gradients, Applications of Partial Derivatives: Tangent Planes and Normal Vectors, Maxima and Minima of Functions of Two Variables.</p>	12
Unit-IV	<p>Matrix: Matrices as vectors, Transpose, Matrix-vector and vector-matrix multiplication in terms of linear combinations, Matrix-vector multiplication in terms of dot-products, Null space, Computing sparse matrix-vector product, Linear functions, Matrix-matrix multiplication, Inner product and outer product, From function inverse to matrix inverse Basis: Coordinate systems, Two greedy algorithms for finding a set of generators, Minimum Spanning Forest and GF(2), Linear dependence, Basis , Unique representation, Change of basis, first look, Computational problems involving finding a basis x Dimension: Dimension and rank, Direct sum, Dimension and linear functions, The annihilator</p>	12
Unit-V		12

	<p>Gaussian elimination: Echelon form, Gaussian elimination over GF(2), Solving a matrix-vector equation using Gaussian elimination, Finding a basis for the null space, Factoring integers,</p> <p>Inner Product: The inner product for vectors over the reals, Orthogonality,</p> <p>Orthogonalization: Projection orthogonal to multiple vectors, Projecting orthogonal to mutually orthogonal vectors, Building an orthogonal set of generators, Orthogonal complement,</p> <p>Eigenvector: Modeling discrete dynamic processes, Diagonalization of the Fibonacci matrix, Eigenvalues and eigenvectors, Coordinate representation in terms of eigenvectors, The Internet worm, Existence of eigenvalues, Markov chains, Modeling a web surfer: PageRank.</p>	
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Textbook:

1. Calculus: Early transcendental (10th Edition): Howard Anton, IrlBivens, Stephen Davis, John Wiley & sons, 2012.
2. Coding the Matrix Linear Algebra through Applications to Computer Science Edition 1, PHILIP N. KLEIN, Newtonian Press (2013)

Additional References:

1. Calculus and analytic geometry (9th edition): George B Thomas, Ross L Finney, Addison Wesley, 1995
2. Calculus: Early Transcendentals (8th Edition): James Stewart, Brooks Cole, 2015.
3. Calculus (10th Edition): Ron Larson, Bruce H. Edwards, Cengage Learning, 2013.
4. Thomas' Calculus (13th Edition): George B. Thomas, Maurice D. Weir, Joel R. Hass, Pearson, 2014..
5. Linear Algebra and Probability for Computer Science Applications, Ernest Davis, A K Peters/CRC Press (2012).
6. Linear Algebra and Its Applications, Gilbert Strang, Cengage Learning, 4th Edition (2007).
7. Linear Algebra and Its Applications, David C Lay, Pearson Education India; 3rd Edition (2002)

Course Code	Course Title	Credits	Practical/ Tutorials Per Week
VESUSDSP 103	Practical of Mathematics for Data Science	1	3
1.	Applications of Derivatives I – a. Increasing and Decreasing functions b. Concavity and inflection points c. Relative Extrema d. Absolute Extrema		

2.	<p>Applications of Derivatives II –</p> <ul style="list-style-type: none"> a. Analysis of polynomials b. Graphing rational functions c. Graphs With Vertical Tangents And Cusps d. Newton’s method to find approximate solution of an equation
3.	<p>Integration –</p> <ul style="list-style-type: none"> a. Finding area using rectangle method and antiderivative method b. Indefinite and definite integrals c. Properties of integrals d. Numerical integration using Simpson’s rule.
4.	<p>Differential Equations –</p> <ul style="list-style-type: none"> a. Solution of a first order first degree differential equation using variable separable method b. Solution of a first order linear differential equation using integrating factor c. Numerical solution of first-order equations using Euler’s method d. Modeling using differential equation
5.	<p>Partial Derivatives I –</p> <ul style="list-style-type: none"> a. Partial derivatives of functions, First and Second order partial derivatives, Mixed derivative theorem, Higher order partial derivatives b. Differential for functions of two or three variables c. Local linear approximation for functions of two or three variables
6.	<p>Partial Derivatives II –</p> <ul style="list-style-type: none"> a. Chain rule for functions of two or three variables b. Implicit differentiation c. Directional derivatives and gradient
7.	<p>Write a program to do the following: - Enter an r by c matrix M (r and c being positive integers)</p>

	<ul style="list-style-type: none"> - Display M in matrix format - Display the rows and columns of the matrix M - Find the scalar multiplication of M for a given scalar. - Find the transpose of the matrix M.
8.	<p>Write a program to do the following:</p> <ul style="list-style-type: none"> - Find the vector –matrix multiplication of a r by c matrix M with an c-vector u. - Find the matrix-matrix product of M with a c by p matrix N. <p>Write a program to enter a matrix and check if it is invertible. If the inverse exists, find the inverse.</p>
9.	<p>Write a program to do the following:</p> <ul style="list-style-type: none"> - Enter a vector b and find the projection of b orthogonal to a given vector u. - Find the projection of b orthogonal to a set of given vectors
10.	<p>Write a program to enter a given matrix and an eigenvalue of the same. Find its eigenvector.</p>
<p>Practical 7.8.9 & 10 can be implemented using Python</p>	

Course Code	Course Title	Credits	Lectures/ Week
VESUSD S104	Descriptive Statistics	3	4
<p>About the Course: This course is designed to provide learners with an understanding of the data and to develop an understanding of the quantitative techniques from Statistics.</p>			
<p>Course Objectives:</p> <ul style="list-style-type: none"> ● To develop the learners ability to deal with different types of data. ● To enable the use of different measures of central tendency and dispersion wherever relevant. ● To make learners aware about the techniques to check the Skewness and Kurtosis of data. ● To develop the ability to analyze statistical data through R software. 			
<p>Learning Outcomes: After successful completion of this course, learners would be able to</p> <ul style="list-style-type: none"> ● Organize, manage and present data. ● Analyze Statistical data using measures of central tendency and dispersion. ● Analyze Statistical data using basics techniques of R. ● Study the relationship between variables using techniques of correlation and regression. 			

Unit-I	<p>Data Types and Data Presentation: Data types: Attribute, Variable, Discrete and Continuous variable, Univariate and Bivariate distribution. Types of Characteristics, Different types of scales: nominal, ordinal, interval and ratio. Data presentation: Frequency distribution, Histogram, Ogive curves.</p>	12
Unit-II	<p>Introduction to R: Data input, Arithmetic Operators, Vector Operations, Matrix Operations, Data Frames, Built-in Functions. Frequency Distribution, Grouped Frequency Distribution, Diagrams and Graphs, Summary statistics for raw data and grouped frequency distribution.</p>	12
Unit-III	<p>Measures of Central tendency: Concept of average/central tendency, characteristics of good measure of central tendency. Arithmetic Mean (A.M.), Median, Mode - Definition, examples for ungrouped and grouped data, effect of shift of origin and change of scale, merits and demerits. Combined arithmetic mean. Partition Values: Quartiles, Deciles and Percentiles - examples for ungrouped and grouped data</p>	12
Unit-IV	<p>Measures dispersion: Concept of dispersion, Absolute and Relative measure of dispersion, characteristics of good measure of dispersion. Range, Semi-interquartile range, Quartile deviation, Standard deviation - Definition, examples for ungrouped and grouped data, effect of shift of origin and change of scale, merits and demerits. Combined standard deviation, Variance. Coefficient of range, Coefficient of quartile deviation and Coefficient of variation (C.V.)</p>	12
Unit-V	<p>Moments: Concept of Moments, Raw moments, Central moments, Relation between raw and central moments. Measures of Skewness and Kurtosis: Concept of Skewness and Kurtosis, measures based on moments, quartiles.</p>	12

Text Book:

1. Trivedi, K.S.(2001) : Probability, Statistics, Design of Experiments and Queuing theory, with applications of Computer Science, Prentice Hall of India, New Delhi

Additional References:

1. Ross, S.M. (2006): A First course in probability. 6th Edⁿ Pearson
2. Kulkarni, M.B., Ghatpande, S.B. and Gore, S.D. (1999): common statistical tests. Satyajeet Prakashan, Pune
3. Gupta, S.C. and Kapoor, V.K. (1987): Fundamentals of Mathematical Statistics, S. Chand and Sons, New Delhi
4. Gupta, S.C. and Kapoor, V.K. (1999): Applied Statistics, S. Chand and Son's, New Delhi
5. Montgomery, D.C. (2001): Planning and Analysis of Experiments, wiley.

Course Code	Course Title	Credits	Practical Per Week
VESUSDSP 104	Practical of Descriptive Statistics (Problem solving and implementation using R)	1	3
1.	Basics of R: a. Data input, Arithmetic Operators b. Vector Operations, Matrix Operations c. Data Frames, Built-in Functions		
2.	R Programming: a. Frequency Distribution, Grouped Frequency Distribution b. Diagrams and Graphs		
3.	3. Frequency distribution and data presentation a. Frequency Distribution (Univariate data/ Bivariate data) b. Diagrams c. Graphs		
4.	4. Mean and Median a. Arithmetic Mean b. Median		
5.	Mode and Partition Values: a. Mode b. Partition Values		
6.	Measures dispersion a. Range and Coefficient of range b. Quartile deviation and Coefficient of quartile deviation c. Standard deviation, Variance and Coefficient of variation (C.V.)		
7.	Moments a. Raw moments b. Central moments		
8.	Measures of Skewness – a. Karl Pearson's measure of Skewness b. Bowley's measure of Skewness c. Moment coefficient of Skewness		
9.	Measures of Kurtosis a. Moment coefficient of Kurtosis (Absolute measure) b. Moment coefficient of Kurtosis (Relative measure)		
10.	Summary Statistics using R a. Summary statistics for raw data		

	b. Summary statistics for grouped frequency distribution
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Course Code	Course Title	Credits	Lectures/ Week
VESUS DS105	Web Technologies	3	4
<p>About the course:</p> <p>This course will teach you how to build a website using various web technologies. This course is designed to start you on a path toward future studies in web development and design.</p>			
<p>Course Objectives:</p> <ul style="list-style-type: none"> ● To provide insight into emerging technologies to design and develop state of - the art web applications with database connections ● To teach students the basics of server side scripting using PHP ● To explain web application development procedures 			
<p>Learning Outcomes:</p> <p>After successful completion of this course, students would be able to</p> <ul style="list-style-type: none"> ● To design valid, well-formed, scalable, and meaningful pages using emerging technologies. ● Understand the various platforms, devices, display resolutions, viewports, and browsers that render websites ● To develop and implement client-side and server-side scripting language programs. ● To develop and implement Database Driven Websites. 			
Unit	Topic	No. of lectures	

I	<p>HTML5: Fundamental Elements of HTML, Formatting Text in HTML, Organizing Text in HTML, Links and URLs in HTML, Tables in HTML, Images on a Web Page, Image Formats, Image Maps, Colors, FORMs in HTML, Interactive Elements, Working with Multimedia - Audio and Video File Formats,</p> <p>HTML elements for inserting Audio / Video on a web page CSS: Understanding the Syntax of CSS, CSS Selectors, Inserting CSS in an HTML Document, CSS properties to work with background of a Page, CSS properties to work with Fonts and Text Styles, CSS properties for positioning an element</p>	12
II	<p>Bootstrap: Downloading the Bootstrap Files, Understanding the File Structure, Creating Your First Web Page with Bootstrap, Including Bootstrap's Files via CDN, Bootstrap Grid System, Creating Fixed Layout with Bootstrap, Creating Fluid Layout with Bootstrap, Bootstrap Tables, Bootstrap Lists, Bootstrap Forms, Bootstrap Images, Bootstrap Typography</p>	12
III	<p>JavaScript: Using JavaScript in an HTML Document, Programming Fundamentals of JavaScript – Variables, Operators, Control Flow Statements, Popup Boxes, Functions – Defining and a Function, Defining Function arguments, Defining a ReInvoking turn Statement, Calling Functions with Timer, event handlers (on click, on submit etc.), JavaScript Objects - String, RegExp, Math, Date, Browser Objects - Window, Navigator, History, Location, Document, Cookies, Document Object Model, Form Validation using JavaScript</p>	12
IV	<p>XML: Introduction to XML, Comparing XML with HTML, Advantages and Disadvantages of XML, Structure of an XML Document, Defining XML tags, their attributes and values, Document type definition, XML Schemas, Document Object model, XHTML Parsing XML Data - DOM, XML Entity References, DTD, XSLT: XSLT</p>	12

V	<p>Introduction to PHP: Declaring variables, data types, arrays, strings, operations, expressions, Control structures, functions, Reading data from web form controls like Text Boxes, radio buttons, lists Etc., Handling File Uploads, Connecting to database (My SQL as reference),executing simple Queries, handling results, Handling sessions and cookies. File,Handling in PHP: File operations like opening, closing, reading, writing,appending, deleting etc. on text,files, listing directories.</p>	12
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Textbooks:

1. **HTML 5 Black Book, Covers CSS 3, JavaScript, XML, XHTML, AJAX, PHP and jQuery, 2ed, Dreamtech Press**
2. **Web Programming and Interactive Technologies, scriptDemics, StarEdu Solutions India.**
3. **PHP: A Beginners Guide, Vikram Vaswani, TMH**
4. **Bootstrap in 24 Hours, Sams Teach Yourself,by Jennifer Kyrnin**

Additional References:

1. **HTML, XHTML, and CSS Bible Fifth Edition, Steven M. Schafer, WILEY**
2. **Learn to Master HTML 5, scriptDemics, StarEdu Solutions Pvt Ltd.**
3. **Learning PHP, MySQL, JavaScript, CSS & HTML5, Robin Nixon, O'Reilly**
4. **PHP, MySQL, JavaScript & HTML5 All-in-one for Dummies, Steve Suehring, Janet Valade Wiley**

Course Code	Course Title	Credits	Practical Per Week
VESUSDS P105	Practical of Web Technologies	1	3
1.	Design a webpage that makes use of a. Document Structure Tags b. Various Text Formatting Tags c. List Tags d. Image and Image Maps		
2.	Design a webpage that makes use of a. Table tags b. Form Tags (forms with various form elements) c. Navigation across multiple pages d. Embedded Multimedia elements		
3.	Design a webpage that make use of Cascading Style Sheets with a. CSS properties to change the background of a Page b. CSS properties to change Fonts and Text Styles c. CSS properties for positioning an element		
4.	Design a web page that makes use of Bootstrap built-in component Grid system.		
5.	Design a form using Bootstrap form component along with Validations		
6.	Write JavaScript code for a. Performing various mathematical operations such as calculating factorial / finding Fibonacci Series / Displaying Prime Numbers in a given range / Evaluating Expressions / Calculating reverse of a number b. Validating the various Form Elements		
7.	Write JavaScript code for a. Demonstrating different JavaScript Objects such as String, RegExp, Math, Date b. Demonstrating different JavaScript Objects such as Window, Navigator, History, Location, Document, c. Storing and Retrieving Cookies		
8.	Create a XML file with Internal / External DTD and display it using a. CSS b. XSL		
9.	Write PHP scripts for a. Retrieving data from HTML forms b. Performing certain mathematical operations such as calculating factorial / finding Fibonacci Series / Displaying Prime Numbers in a given range / Evaluating Expressions / Calculating reverse of a number c. Working with Arrays d. Working with Files (Reading / Writing)		
10.	Write PHP scripts for a. Working with Databases (Storing Records / Reprieving Records and Display them) b. Storing and Retrieving Cookies c. Storing and Retrieving Sessions		

FYBSc

Semester II

Course Code	Course Title	Credits	Lectures / Week
VESUSDS 201	DBMS & NoSQL	3	4

About the course:

To develop understanding of concepts and techniques for data management and learn about widely used systems for implementation and usage. It also provides students with theoretical knowledge and practical skills of creating and manipulating data with interactive query languages like (MySQL,PL SQL and NO SQL).

Course Objectives:

- To make students aware of the fundamentals of the database system.
- To give an idea how ERD components are helpful in database design and implementation. To experience the students working with databases using MySQL and NO SQL.
- To familiarize the student with normalization, database protection and different DCL Statements.
- To make students aware about the importance of protecting data from unauthorized users.
- To make students aware of granting and revoking rights of data manipulation.
- Master concepts of stored procedure and triggers and its use.
- Learn about using PL/SQL for data management.

Learning Outcomes:

After successful completion of this course, students would be able to

- To appreciate the importance of database design.
- Analyze database requirements and determine the entities involved in the system and their relationship to one another.
- Write simple queries to MySQL related to String, Maths and Date Functions.
- Create tables and insert/update/delete data, and query data in a relational DBMS using MySQL and NOSQL commands.
- Understand the normalization and its role in the database design process.

Unit	Topic	No. of lectures
I	<p>Introduction to DBMS – Database, DBMS – Definition, Overview of DBMS, Advantages of DBMS, Levels of abstraction, Data independence, DBMS Architecture</p> <p>Entity Relationship Model - Entities, attributes, entity sets, relations, relationship sets, Additional constraints (key constraints, participation constraints, weak entities, aggregation / generalization, Conceptual Design using ER (entities VS attributes, Entity Vs relationship, binary Vs ternary, constraints beyond ER)</p> <p>ER to Table- Entity to Table, Relationship to tables with and without key constraints.</p> <p>DDL Statements - Creating Databases, Using Databases, data types, Creating Tables (with integrity constraints – primary key, default, check, not null), Altering Tables, Renaming Tables, Dropping Tables, Truncating Tables</p> <p>DML Statements – Viewing the structure of a table insert, update, delete, Select all columns, specific columns, unique records, conditional select, in clause, between clause, limit, aggregate functions (count, min, max, avg,</p>	12

	sum), group by clause, having clause	
II	<p>Relational data model– Domains, attributes, Tuples and Relations, Relational Model Notation, Characteristics of Relations, Relational Constraints - primary key, referential integrity, unique constraint, Null constraint, Check constraint</p> <p>Relational Algebra operations (selection, projection, set operations union, intersection, difference, cross product, Joins –conditional, equi join and natural joins, division)</p> <p>Functions – String Functions (concat, instr, left, right, mid, length, lcase/lower, ucase/upper, replace, strcmp, trim, ltrim, rtrim), Math Functions (abs, ceil, floor, mod, pow, sqrt, round, truncate) Date Functions (adddate, datediff, day, month, year, hour, min, sec, now, reverse)</p> <p>Joining Tables – inner join, outer join (left outer, right outer, full outer)</p> <p>Subqueries – subqueries with IN, EXISTS, subqueries restrictions, Nested subqueries, ANY/ALL clause, correlated subqueries</p>	12
III	<p>Schema refinement and Normal forms: Functional dependencies, first, second, third, and BCNF normal forms based on primary keys, lossless join decomposition.</p> <p>Database Protection: Security Issues, Threats to Databases, Security Mechanisms, Role of DBA, Discretionary Access Control, Backing Up and Restoring databases</p> <p>Views (creating, altering dropping, renaming and manipulating views)</p> <p>DCL Statements (creating/dropping users, privileges introduction, granting/revoking privileges, viewing privileges), Transaction control commands – Commit, Rollback</p>	12
IV	<p>Fundamentals of PL/SQL: Defining variables and constants, PL/SQL expressions and comparisons: Logical Operators, Boolean Expressions, CASE Expressions Handling, Null Values in Comparisons and Conditional Statements, PL/SQL Datatypes: Number Types, Character Types, Boolean Type, Datetime and Interval Types.</p> <p>Overview of PL/SQL Control Structures: Conditional Control: IF and CASE Statements, IF-THEN Statement, IF-THEN-ELSE Statement, IF THEN-ELSE IF Statement, CASE Statement, Iterative Control: LOOP and EXIT Statements, WHILE-LOOP, FOR-LOOP, Sequential Control: GOTO and NULL Statements</p> <p>Stored Procedures: Types and benefits of stored procedures, creating stored procedures, executing stored procedures, altering stored procedures, viewing stored procedures.</p> <p>Triggers: Concept of triggers, Implementing triggers – creating triggers, Insert, delete, and update triggers, nested triggers, viewing, deleting and modifying triggers, and enforcing data integrity through trigger</p>	12

V	NoSQL What is NoSQL, Features, Types, Pros-Cons, RDBMS VS NoSQL, Overview of NoSQL Databases MongoDB - Features, Creating-updating-deleting databases, Creating- updating-deleting collections, inserting-updating-searching-sorting documents	12
Textbooks: <ol style="list-style-type: none"> 1. “Fundamentals of Database System”, ElmasriRamez, NavatheShamkant, Pearson Education, Seventh edition, 2017 2. “Database Management Systems”, Raghu Ramakrishnan and Johannes Gehrke, 3rd Edition, 2014 3. “Murach's MySQL”, Joel Murach, 3rd Edition, 3rd Edition, 2019 4. Abraham Silberschatz, Henry F. Korth,S. Sudarshan , Database System Concepts, 6th Edition 5. Ivan Bayross, “SQL,PL/SQL -The Programming language of Oracle”, B.P.B. Publications Additional References: <ol style="list-style-type: none"> 1. https://docs.mongodb.com/manual/tutorial/getting-started/ 2. MongoDB Complete Guide, Manu Sharma, BPB Publication 		

Course Code	Course Title	Credits	Practical Per Week
VESUSDSP 201	Practical of DBMS & NoSQL	1	3
1	Conceptual Designing using ER Diagrams (Identifying entities, attributes, keys and relationships between entities, cardinalities, generalization, specialization etc.)		
2	Perform the following: <ul style="list-style-type: none"> ● Viewing all databases ● Creating a Database ● Viewing all Tables in a Database ● Creating Tables (With and Without Constraints) ● Inserting/Updating/Deleting Records in a Table ● Altering a Table ● Dropping/Truncating/Renaming Tables 		
3	Perform the following: <ul style="list-style-type: none"> ● Simple Queries ● Simple Queries with Aggregate functions ● Date Functions ● String Functions ● Math Functions 		

4	<p>Join Queries</p> <ul style="list-style-type: none"> ● Inner Join ● Outer Join ● Subqueries ● With IN clause ● With EXISTS clause
5	<p>Views</p> <ul style="list-style-type: none"> ● Creating Views (with and without check option) ● Dropping views ● Selecting from a view ● DCL statements ● Granting and revoking permissions ● Saving (Commit) and Undoing (rollback)
6	<p>Writing PL/SQL Blocks with basic programming constructs by including following:</p> <ol style="list-style-type: none"> a. If...then...Else, IF...ELSIF...ELSE... END IF b. Case statement c. While-loop Statements d. For-loop Statements.
7	<p>Writing Functions in PL/SQL Block.</p> <ol style="list-style-type: none"> a. Define and call a function b. Define and use function in select clause, c. Call function in dbms_output.put_line d. Recursive function
8	<p>Writing Procedures in PL/SQL Block.</p> <ol style="list-style-type: none"> a. Create an empty procedure, replace a procedure and call procedure b. Create a stored procedure and call it c. Define procedure to insert data d. A forward declaration of procedure
9	Create-Update-Delete Databases and Collections
10	Insert-Update-Delete-Sort-Search through collections

Course Code	Course Title	Credits	Lectures / Week
VESUSDS	Advanced Python	3	4

202			
<p>About the course:</p> <p>This course aims to explore and enable learners to master the skills of advanced topics in Python Programming. It helps learners develop advanced skills such as working with databases, matching patterns, and exception handling and GUI in Python along with the data visualization. It also highlights why Python is a useful scripting language for all developers.</p> <p>Programming for implementing applications for emerging fields including data science and machine learning.</p>			
<p>Course Objectives:</p> <ul style="list-style-type: none"> ● To learn about reading, writing and implementing other operations on files in Python. ● To design GUI Programs and implement database interaction using Python. ● To know about the use of regular expression and handling exceptions for writing robust python programs. 			
<p>Learning Outcomes:</p> <p>After successful completion of this course, students would be able to</p> <ul style="list-style-type: none"> ● Ability to work with files and perform operations on it using Python. ● Ability to implement regular expression for developing efficient program ● Ability to implement exception handling in Python applications for error handling. ● Knowledge of working with databases, designing GUI in Python and implement networking in Python 			
Unit	Topic		No. of lectures
I	<p>Working with files: Files, opening and closing a file, working with text files containing strings, knowing whether a file exists or not, working with binary files, the ‘with’ statement, the seek() and tell() methods, random accessing of binary files, zipping and unzipping files, working with directories, running other programs from python program Regular expressions: Regular expressions : sequence characters in regular expressions, quantifiers in regular expressions, special characters in regular expressions, using regular expressions on files.</p>		12
II	<p>Exception handling in databases : Exceptions in python: Errors in a python program, compile & run-time errors, logical error, exceptions-exception handling, types of exceptions, the except block, the assert statement, user-defined exceptions, logging the exceptions Database Connectivity with Python: Using SQL with python, retrieving rows from a table, inserting rows into a table, deleting rows from a table, updating rows in a table, creating database tables through python,</p>		12

III	Graphical user interface: Creating a GUI in python, Widget classes, Working with Fonts , Shapes and Colors, working with Frames, Layout manager, Event handling using the root component, adding an Entry, Label, Check Buttons, Message Box etc.	12
IV	Data Visualization Data reading using Python functions, Python libraries: pandas, plotly, matplotlib, data collection from online data sources, web scrap, data formats such as html, csv, MS-Excel, Data visualization using Python libraries- Different graphs such as Scatterplot, line chart, histogram, Bar chart, Bubble chart. Pandas : Data Structures related to Pandas, Series, Dataframes, To create a data series using Pandas, To create data frames using pandas, Visualization using Pandas	12
V	Python Framework-Create a Django Application Features of Django, Django web server, Understanding Django environment, Django Project, A simple 'Hello world' application	12
<p>Textbooks:</p> <ol style="list-style-type: none"> 1. Python for Data Analysis, DATA WRANGLING WITH PANDAS, NUMPY, AND IPYTHON, O'Reilly Publications 2. Let Us Python, Yashwant. B. Kanetkar, BPB Publication, 2019. 3. Practical Programming: An Introduction to Computer Science Using Python 3, Paul Gries , Jennifer Campbell, Jason Montojo, Pragmatic Bookshelf, 2nd Edition <p>Additional References:</p> <ol style="list-style-type: none"> 1. Python: The Complete Reference, Martin C. Brown, McGraw Hill, 2018 2. Programming in Python, Mark Summerfield, Pearson Education, 2nd Ed, 2018 3. Python Programming: Using Problem Solving Approach, Reema Thareja, Oxford University Press, 2017 		

Course Code	Course Title	Credits	Practical Per Week
VESUSDSP 202	Practical of Advanced Python	1	3

1	Write a Python program to implement various file operations.
2	Write a Python program to demonstrate use of regular expressions for suitable applications.
3	Write a Python Program to work with databases in Python to perform operations such as a. Connecting to database b. Creating and dropping tables c. Inserting and updating into tables.
4	Write a Python Program to demonstrate different types of exception handling.
5	Write a GUI Program in Python to design application that demonstrates a. Different fonts , shapes and colors b. Different Layout Managers c. Event Handling
6	Write a program to implement a Python program using database connectivity.
7	Develop a short program using database connectivity with Python GUI using Tkinter.
8	Write a Python program to implement data visualization using Pandas.
9	Implement a Django Python framework and create a webpage using it.
10	Write a Pandas program to convert a NumPy array to a Pandas series and to convert a Panda module Series to Python list along with demonstration of data visualization using Pandas.

Course Code	Course Title	Credits	No. of Lectures /Week
VESUSDS 203	Research Methodology	3	4

About the course:

In order to give an impetus to research among students, this subject gives an overview on how to carry out research in Computer Science. The students would be able to carry out a review of the research papers along with the publication of the research paper.

Course Objectives:

- Identify and nurture research temper among students.
- In order to give an impetus to research among students, this course gives an overview on how to do research in Computer Science.
- Experience the students' inclination towards research and increase the pursuit of research

Learning Outcomes:

After successful completion of this course, students would be able to

- understand the design of samples and how to analyze those
- implement literature review
- process and analyze the data samples
- to write down the research paper/technical paper and research report

Unit	Topic	
I	Research: What does it mean? Characteristics of Research Research Methods versus Methodology, Research and Scientific Method. Types of Research: Descriptive versus Analytical, Applied versus Fundamental, Quantitative versus Qualitative, Conceptual versus Empirical. Research Process. Formulating a Research Problem: Reviewing Literature, formulating a Research Problem, Identifying Variables, Constructing Hypothesis	12
II	The Research Design: Meaning, Need for Research Design, Important Concepts, Different Research Designs, Basic Principles of Experimental Designs. Research design: Meaning, Need, Features of Good Design, Concepts, Types. Basic principles of Experimental Design, various methods of Research. Survey, Philosophical, Historical, Experimental, Causal Comparative, Genetic, Case Studies. Collecting Data: Considering Ethical Issues in Data Collection, Methods of Data Collection. Collections of Primary Data, Collection of Data through questionnaire and Schedules, other Observation Interview Methods, Collection of Secondary Data, Selection of appropriate method for data collection, Case Study, Focus Group Discussion, Techniques of developing research tools, viz. Questionnaire and rating scales etc. Reliability and validity of Research tools. Sampling Design: Steps in Sampling Design, Criteria of Selecting a Sampling Procedure, Characteristics of a Good Sample Design, Different Types of Sample Designs, How to Select a Random Sample.	12
III	Processing and Analysis of Data: Processing Operations, Some Problems in Processing, Elements/Types of Analysis, Statistics in	12

	<p>Research, Measures of Central Tendency, Measures of Dispersion, Measures of Asymmetry (Skewness), Measures of Relationship, Simple Regression Analysis, Multiple Correlation and Regression, Partial Correlation, Association in Case of Attributes.</p> <p>Hypothesis Testing: What is a Hypothesis?, Basic Concepts Concerning Testing of Hypotheses, Procedure for Hypothesis Testing, Flow Diagram for Hypothesis Testing, Tests of Hypotheses, One sided and Two sided hypothesis, Critical region, p-value, Confidence intervals, Conducting a Hypothesis Test, Type – I and Type – II errors.</p>	
IV	<p>Technical Writing: Writing a Research Proposal, What is a Scientific Paper? Ethics in Scientific Publishing.</p> <p>Preparing the Text: How to Prepare the Title, How to List the Authors and Addresses, How to Prepare the Abstract, How to Write the Introduction, How to Write the Materials and Methods Section, How to Write the Results, How to Write the Discussion, How to State the Acknowledgments, How to Cite the References.</p> <p>Preparing the Tables and Figures: How to Design Effective Tables, How to Prepare Effective Graphs, How to Prepare Effective Photographs.</p> <p>Publishing the Paper: Rights and Permissions, How to Submit the Manuscript, How and When to Use Abbreviations, How to Write a Thesis, Outcome of Research</p>	12
V	<p>Writing Research Report: Format and style. Review of related literature and its implications at various stages of research. (Formulation of research problem, hypothesis, interpretation and discussion of results). Major findings, Conclusions and suggestions. Citation of references and Bibliography.</p>	12
<p>Textbooks:</p> <ol style="list-style-type: none"> 1. Best and Kahn, Research Methodology, PHI Limited. 2. Kothari, C.R. Research Methodology (Methods and Techniques), New Age Publisher 3. Ranjit Kumar, Research Methodology-A Step-by-Step Guide for Beginners, (4th ed.), 2014, Singapore, Pearson Education. 4. Robert, A. Day, How to Write and Publish a Scientific Paper, Cambridge University Press, Great Britain. <p>Additional References:</p> <ol style="list-style-type: none"> 1. Design of Experience: Statistical Principles of Research Design and Analysis, by Robert O. Kuehl Brooks/cole. 		

Course Code	Course Title	Credits	Practical/ Tutorials
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			Per Week
VESUSDSP 203	Practical of Research Methodology	1	3
1.	Import data from different data-sources		
2.	Pre-processing the data / cleaning the data		
3.	Obtain descriptive statistics of data		
4.	Implement data analysis and visualization.		
5.	Implementing hypothesis testing.		
6.	Implementing ANOVA.		
7.	Perform random sampling for the given data and analyze it		
8.	Compute different types of correlation.		
9.	Implementing Regression Techniques - Linear and Multiple linear regression		
10.	To Write a Paper and format it Using LATEX.		

Course Code	Course Title	Credits	Lectures /Week
VESUSDS 204	Probability and Inferential Statistics	3	4
About the Course: This course is designed to provide learners with an understanding of the data and to develop an understanding of the quantitative techniques from Statistics. It also provides the knowledge of different statistical tools used for primary statistical analysis of data.			
Course Objectives:			

- To make learner enable to find the correlation between different variables and further apply the regression analysis to find the exact relation between them.
- To develop ability to analyze statistical data through R software.
- To make learner aware about basic probability axioms and rules and its application.
- To understand the concept of conditional probability and Independence of events.
- To make learner familiar with discrete and continuous random variables as well as standard discrete and continuous distributions.
- To learn computational skills to implement various statistical inferential approaches.

Learning Outcomes:

After successful completion of this course, learners would be able to

- Study the relationship between variables using techniques of correlation and regression.
- Calculate probability, conditional probability and independence.
- Apply the given discrete and continuous distributions whenever necessary.

Unit-I	Probability: Random experiment, sample space, events types and operations of events, Probability definition: classical, axiomatic, Elementary Theorems of probability (without proof). Conditional probability, „Bayes“ theorem, independence, Examples on Probability.	12
Unit-II	Random Variables: Concept and definition of a discrete random variable and continuous random variable. Probability mass function, Probability density function and cumulative distribution function of discrete and continuous random variable, Properties of cumulative distribution function	12
Unit-III	Mathematical Expectation and Variance: Expectation of a function, Variance and S.D of a random variable, properties. Standard Probability distributions: Introduction, properties, examples and applications of each of the following distributions: Binomial distribution, Normal distribution, Chi-square distribution, t distribution, F distribution	12
Unit-IV	Hypothesis testing: one sided, two sided hypothesis, critical region, p-value, tests based on t, Normal and F, confidence intervals. Analysis of variance : one-way, two-way analysis of variance	12
Unit-V	Correlation: Concept of correlation, Types and interpretation, Measure of Correlation: Scatter diagram and interpretation; Karl Pearson’s coefficient of correlation (r): Definition, examples for ungrouped and grouped data, effect of shift of origin and change of scale, properties; Spearman’s rank correlation coefficient: Definition, examples of with and without repetition. Concept of Multiple correlation. Regression: Concept of dependent (response) and independent (predictor) variables, concept of regression, Types and prediction,	12

	<p>difference between correlation and regression, Relation between correlation and regression.</p> <p>Linear Regression - Definition, examples using least square method and regression coefficient, coefficient of determination, properties. Concept of Multiple regression and Logistic regression.</p>	
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Text Book:

1. Trivedi, K.S.(2009) : Probability, Statistics, Design of Experiments and Queuing theory, with applications of Computer Science, Prentice Hall of India, New Delhi

Additional References:

1. Ross, S.M. (2006): A First course in probability. 6th Edⁿ Pearson
2. Kulkarni, M.B., Ghatpande, S.B. and Gore, S.D. (1999): Common statistical tests. Satyajeet Prakashan, Pune
3. Gupta, S.C. and Kapoor, V.K. (2002) : Fundamentals of Mathematical Statistics, S. Chand and Sons, New Delhi
4. Gupta, S.C. and Kapoor, V.K. (4th Edition) : Applied Statistics, S. Chand and Son's, New Delhi
5. Montgomery, D.C. (2001): Planning and Analysis of Experiments, Wiley.

Course Code	Course Title	Credits	Practical/ Tutorials Per Week
VESUSDSP 204	Probability and Inferential Statistics (Problem solving and implementation using R)	1	3
1.	<p>Probability-</p> <p>a. Examples based on Probability definition: classical, axiomatic</p> <p>b. Examples based on elementary Theorems of probability</p>		
	<p>Conditional probability Bayes' theorem and independence-</p> <p>a. Examples based on Conditional probability.</p> <p>b. Examples based on „Bayes' theorem</p> <p>c. Examples based on independence</p>		
2.	<p>Discrete random variable-</p> <p>a. Probability distribution of discrete random variable</p> <p>b. Probability mass function</p>		
3.	<p>Continuous random variable-</p> <p>a. Probability distribution of continuous random variable</p> <p>b. Probability density function</p>		
4.	<p>Mathematical Expectation and Variance-</p> <p>a) Mean of discrete and continuous Probability distribution</p> <p>b) S.D. and variance of discrete and continuous Probability distribution</p>		

5.	Standard probability distributions- a. Calculation of probability, mean and variance based on Binomial distribution b. Calculation of probability based on Normal distribution
6.	Large Sample tests based on Normal (Z) - a. Test of significance for proportion (Single proportion $H_0: P = P_0$) b. Test of significance for difference between two proportions (Double proportion $H_0: P_1 = P_2$) c. Test of significance for mean (Single mean $H_0: \mu = \mu_0$) d. Test of significance for difference between two means. (Double mean $H_0: \mu_1 = \mu_2$)
7.	Small sample tests based on t and F- a. t-test for significance of single mean, population variance being unknown (Single mean $H_0: \mu = \mu_0$) b. t-test for significance of the difference between two sample means (Independent samples) c. t-test for significance of the difference between two sample means (Related samples) d. F-Test to Compare Two Variances
8.	Analysis of variance - a. Perform One-way ANOVA b. Perform Two-way ANOVA
9.	Correlation a. Karl Pearson's correlation coefficient b. Spearman's Rank correlation
10.	Regression a. Method of least squares b. Using regression coefficients c. Properties of regression lines & regression coefficients

Course Code	Course Title	Credits	Lectures / Week
VESUSDS 205	Soft Skill	3	4

About the course

To help learners develop their soft skills and personality along with technical skills by focusing on various communication types, academic and professional skills.

Course Objectives**The objectives of this course are:**

- Understand the significance and essence of a wide range of soft skills.
- Learn how to apply soft skills in a wide range of routine social and professional settings
- Learn how to employ soft skills to improve interpersonal relationships
- Learn how to employ soft skills to enhance employability and ensure workplace and career success

Learning Outcomes

After successful completion of this course -

- Learners will be able to understand the importance and types softs kills
- earners will develop skills for Academic and Professional Presentations.
- Learners will be able to understand Leadership Qualities and Ethics.
- Learners will be able to understand what holistic well-being is about and how to practise it

Unit	Topic	No. of lectures
I	Soft Skill - Introduction, Importance, Different types of soft skills Personality Development - Knowing yourself, Positive thinking, Johar’s Window, SWOT Analysis Emotional Intelligence - Meaning and Definition, Need for Emotional Intelligence, Intelligence Quotient versus Emotional Intelligence Quotient, Components of Emotional Intelligence, Competencies of Emotional Intelligence, Skills to Develop Emotional Intelligence Positivity and Motivation: Developing Positive Thinking and Attitude; Driving out Negativity; Enhancing Motivation Levels Capacity Building: Learn, Unlearn and Relearn: Capacity Building, Elements of Capacity Building, Zones of Learning, Ideas for Learning, Strategies for Capacity Building	12
II	Basic Skills in Communication: Components of effective communication: Communication process and handling them, Composing effective messages, Non – Verbal Communication: its importance and nuances: Facial Expression, Posture, Gesture, Eye contact, appearance (dress code).	12

	<p>Employment Communication: Introduction, Resume, Curriculum Vitae, Developing an Impressive Resume, Formats of Resume, Job Application or Cover Letter</p> <p>Writing emails effectively : Components of an email and their function, do's and don'ts of email writing, tips to manage mailboxes and communicate effectively</p>	
III	<p>Job Interviews: Introduction, Importance of Resume, Definition of Interview, Types of Interviews, Preparatory Steps for Job Interviews, Interview Skill Tips, Changes in the Interview Process, FAQ During Interviews</p> <p>Group Discussion: Introduction, Ambience/Seating Arrangement for Group Discussion, Importance of Group Discussions, Difference between Group Discussion, Panel Discussion and Debate, Traits, Types of Group Discussions, topic based and Case based Group Discussion, Individual Traits</p> <p>Professional Presentation: Nature of Oral Presentation, planning a Presentation, Preparing the Presentation, Delivering the Presentation</p>	12
IV	<p>Etiquette and Mannerism: Introduction, Professional Etiquette, Technology Etiquette</p> <p>Ethical Values: Ethics and Society, Theories of Ethics, Nurturing Ethics, Importance of Work Ethics, Problems in the Absence of Work Ethics</p> <p>Creativity at Workplace: Introduction, Current Workplaces, Creativity, Motivation, Nurturing Hobbies at Work, The Six Thinking Hat Method.</p>	12
V	<p>Leadership and Team Building: Leader and Leadership, Leadership Traits, Culture and Leadership, Leadership Styles and Trends, Team Building, Types of Teams.</p> <p>Decision Making and Negotiation: Introduction to Decision Making, Steps for Decision Making, Decision Making Techniques, Negotiation Fundamentals, Negotiation Styles</p> <p>Holistic Well-being for young adults: Time Management, Stress Management, Goal Setting, Physical and Mental well-being,</p>	12

TextBooks :

1. Managing Soft Skills for Personality Development – edited by B.N.Ghosh, McGraw Hill India, 2017.
2. Soft Skills: An Integrated Approach to Maximize Personality, Gajendra S. Chauhan, Sangeeta Sharma, Wiley India

Additional References:

1. Personality Development and Soft Skills, Barun K. Mitra, Oxford Press
2. Business Communication, ShaliniKalia, Shailja Agrawal, Wiley India
3. Cornerstone: Developing Soft Skills, Sherfield, Pearson India

Course Code	Course Title	Credits	Practical/ Tutorials Per Week
VESUSDSP 205	Practical of Soft Skill	1	3
1	Practical on how to use Word Processing Software - 1(covering basic functionality and typing rules)		
2	Practical on how to use Word Processing Software - 2(covering advanced functionality)		
3	Create Resume, Job Applications, etc using Word Processing Software. Also send it to multiple employers using mail-merge.		
4	Create Letters, Proposals, etc using Word Processing Software		
5	Practical on how to use Presentation Software - 1(covering basic functionality)		
6	Practical on how to use Presentation Software - 2(covering advanced functionality)		
7	Create a Technical Presentation using Presentation Software		
8	Create a Non-Technical Presentation using Presentation Software		
9	Practical on how to use Mind Map making software		
10	Creating mind maps		

Academic year 2023-2024

Second Year (Semester III)

Assuming 15 weeks of teaching and Practical Batch Size(30)

Title of the Course	Number of Lectures/ Practs	(Theory) per week	(Practical) per week	Credits
Algorithms and Data Structures	60	4	-	2
Introduction to Data Science	60	4	-	2
Advanced Statistical Methods	60	4	-	2
Data Warehousing and Data Mining	60	4	-	2
IoT	60	4	-	2
Practical of Algorithms and Data Structures	45	-	3	2
Practical of Introduction to Data Science	45	-	3	2
Practical of Advanced Statistical Methods	45	-	3	2
Practical of Data Warehousing and Data Mining	45	-	3	2
Practical of IoT	45	-	3	2
Total				20

Second Year (Semester IV)

Title of the Course	Number of Lectures/Practs	(Theory) per week	(Practical) per week	Credits
Object Oriented Programming using Java	60	4	-	2
AI & Machine Learning	60	4	-	2
Software Engineering	60	4	-	2
Cloud Computing	60	4	-	2
Mobile Programming	60	4	-	2
Practical of Object Oriented Programming using Java	45	-	3	2

Practical of AI & Machine Learning	45	-	3	2
Practical of Software Engineering	45	-	3	2
Practical of Cloud Computing	45	-	3	2
Practical of Mobile Programming	45	-	3	2
Total				20

SYBSc

Semester III

Course Code	Course Title	Credits	Lect/ Week
	Algorithms and Data Structures	3	5
<p>About the course</p> <p>The course covers the concepts of - (i) calculating complexity of algorithms, (ii) the essential operations like searching, sorting, selection, pattern matching & recursion, and (iii) various algorithmic strategies like greedy, divide-n-conquer, dynamic programming, backtracking and implementations of all these on basic data structures like array, list and stack.(iv) data structures like trees and graphs, how to create them and various algorithms on it</p>			
<p>Course Objectives</p> <p>The objectives of this course are:</p> <p>The objectives of this course are:</p> <ul style="list-style-type: none"> ● To make students understand the basic principles of algorithm design ● To give idea to students about the theoretical background of the basic data structures ● To familiarize the students with fundamental problem-solving strategies like searching, sorting, selection, recursion and help them to evaluate efficiencies of various algorithms. ● To teach students the important algorithm design paradigms and how they can be used to solve various real world problems. 			
<p>Learning Outcomes</p> <p>After successful completion of this course -</p> <ul style="list-style-type: none"> ● Students should be able to understand and evaluate efficiency of the programs that they write based on performance of the algorithms used. ● Students should be able to appreciate the use of various data structures as per need ● To select, decide and apply appropriate design principle by understanding the requirements 			

of any real life problems		
Unit	Topic	No. of lectures
I	<p>Introduction to algorithms - What is algorithm, analysis of algorithm, Types of complexity, Running time analysis, How to Compare Algorithms, Rate of Growth, Types of Analysis, Asymptotic Notation, Big-O Notation, Omega-Ω Notation, Theta-Θ Notation, Asymptotic Analysis, Performance characteristics of algorithms, Estimating running time / number of steps of executions on paper, Idea of Computability</p> <p>Introduction to Data Structures - What is data structure, types, Introduction to Array(1-d & 2-d), Stack and List data structures, operations on these data structures, advantages disadvantages and applications of these data structures like solving linear equations, Polynomial Representation, Infix-to-Postfix conversion</p>	12
II	<p>Recursion - What is recursion, Recursion vs Iteration, recursion applications like Factorial of a number, Fibonacci series & their comparative analysis with respect to iterative version, Tower of hanoi problem</p> <p>Basic Sorting Techniques - Bubble, Selection and Insertion Sort & their comparative analysis</p> <p>Searching Techniques - Linear Search and its types, Binary Search and their comparative analysis</p> <p>Selection Techniques - Selection by Sorting, Partition-based Selection Algorithm, Finding the Kth Smallest Elements in Sorted Order & their comparative analysis</p>	12
III	<p>Algorithm Design Techniques - Introduction to various types of classifications/design criteria and design techniques</p> <p>Greedy Technique - Concept, Advantages & Disadvantages, Applications, Implementation using problems like - file merging problem</p> <p>Divide-n-Conquer - Concept, Advantages & Disadvantages, Applications, Implementation using problems like - merge sort, Strassen's Matrix Multiplication</p> <p>Dynamic Programming - Concept, Advantages & Disadvantages, Applications, Implementation using problems like - Fibonacci series, Factorial of a number, Longest Common subsequence</p>	12

IV	<p>Backtracking Programming - Concept, Advantages & Disadvantages, Applications, Implementation using problems like N-Queen Problem</p> <p>Abstract Data Types: Introduction, The Date Abstract Data Type, Collection, Linked Structures: Introduction, Singly Linked List-Traversing, Searching, Prepending and Removing Nodes, Bag ADT-Linked List Implementation.</p> <p>Stacks: Stack ADT, Implementing Stacks-Using Python List, Using Linked List, Stack Applications-Balanced Delimiters, Evaluating Postfix Expressions</p>	12
V	<p>Binary Trees: Tree Structure, Binary Tree-Properties, Implementation and Traversals, Binary Search Tree, Balanced BST, Threaded Binary Trees, AVL Trees,</p> <p>Graph : Introduction, Applications of Graphs, Graph Representation, Graph Traversals, Shortest Path Algorithms, Minimal Spanning Tree</p> <p>Graph basics, Terminologies, Matrix and Adjacency List Representation of Graphs, Elementary Graph operations – Shortest-Path Algorithms–Un weighted Shortest Paths–Minimum Spanning Tree– Applications of Depth First Search, Breadth First Search.</p>	12

TextBooks :

1. “Data Structure and Algorithm Using Python”, Rance D. Necaie, Wiley India Edition, 2016.
2. “Data Structures and Algorithms Made Easy”, Narasimha Karumanchi, CareerMonk Publications, 2016.
3. “Introduction to Algorithms”, Thomas H. Cormen, 3rd Edition, PHI.

Additional References:

1. “Introduction to the Design and Analysis of Algorithms”, Anany Levitin, Pearson, 3rd Edition, 2011.
2. “Design and Analysis of Algorithms”, S. Sridhar, Oxford University Press, 2014.

Course Code	Course Title	Credits	Practical/ Tutorials Per Week
	Practical of Algorithms and Data Structures	1	3
1	Programs on 1-d arrays like - sum of elements of array, searching an element in array, finding minimum and maximum element in array, count the number of even and odd numbers in array. For all such programs, also find the time complexity, compare if there are multiple methods		

	Programs on 2-d arrays like row-sum, column-sum, sum of diagonal elements, addition of two matrices , multiplication of two matrices. For all such programs, also find the time complexity, compare if there are multiple methods
2	Program to create a list-based stack and perform various stack operations.
3	Program to perform linear search and binary search on list of elements. Compare the algorithms by calculating time required in milliseconds using readymade libraries.
4	Programs to sort elements of list by using various algorithms like bubble, selection sort, and insertion sort. Compare the efficiency of algorithms.
5	Programs to select the Nth Max/Min element in a list by using various algorithms. Compare the efficiency of algorithms.
6	Programs on recursion like factorial, fibonacci, tower of hanoi. Compare algorithms to find factorial/fibonacci using iterative and recursive approaches.
7	Program to implement file merging, coin change problems using Greedy Algorithm and to understand time complexity. Program to implement merge sort, Straseen's Matrix Multiplication using D-n-C Algorithm and to understand time complexity.
8	Program to implement fibonacci series, Longest Common Subsequence using dynamic programming and to understand time complexity. Compare it with the general recursive algorithm. Program to implement N-Queen Problem, Binary String generation using Backtracking Strategy and to understand time complexity
9	Programs on Trees Write Python program for inserting an element into binary tree. Write Python program for deleting an element (assuming data is given) from binary tree.
10	Programs on Graphs Write Python program for checking whether a given graph G has simple path from source s to destination d. Assume the graph G is represented using adjacent matrix.

Course Code	Course Title	Credits	Lect/Week
	Introduction to Data Science	3	5

About the course

The course aims to introduce the basic concepts of data science from how to get the data till how to get actionable insights on the data.

Course Objectives**The objectives of this course are:**

- Provide insights how to analyze data
- Learn techniques and tools to process and transform data
- Students should be able to understand organization's data, analyze and give valuable information to clients.

Learning Outcomes

After successful completion of this course -

- Students will know relevant programming tools/technologies.
- Students will demonstrate proficiency with processing of data.
- Students will demonstrate skill in data management.
- Students will apply data science concepts and methods to solve problems in real-world contexts and will communicate these solutions effectively

Unit	Topic	No. of lectures
I	Introduction to Data Science: What is Data? Different kinds of data, Data Acquisition - Gather information from different sources. Internal systems and External systems. Web APIs, Open Data Sources, Data APIs, Web Scrapping Relational Database access (queries) to process/access data.	12
II	Data Pre-processing and Preparation, Data Cleaning, Data Quality and Transformation Dimension reduction, Feature extraction, Smoothing and aggregating	12
III	Data Analysis - Exploratory Data Analysis (EDA), Finding patterns, draw actionable insights,	12
IV	Data Visualization - Different types of graphs, charts, Data Storytelling	12
V	Data Management - Introduction, data science vs data management, activities under data management, data management best practices, tools and techniques, risks and challenges, data management roles,	12

TextBooks :

1. Introduction to Data Science: Practical Approach with R and Python by B. Uma Maheswari and R. Sujatha
2. Data Science Fundamentals And Practical Approaches: Understand Why Data Science Is The Next: Understand Why Data Science Is the Next (English Edition) – 1 January 2020, by Dr Gypsy Anand/ Dr Rupam Sharma
3. Data Science and Analytics Paperback – 1 January 2018 by V. K. Jain

Additional References:

1. The Power of Data Storytelling by Sejal Vora
2. Advanced Analytics With Excel 2019: Perform Data Analysis Using Excel's Most Popular Features (English Editions) by Manisha Nigam

Course Code	Course Title	Credits	Practical/ Tutorials Per Week
	Practical of Introduction to Data Science	1	3
	Practicals in R, Excel and other technologies to cover the concepts of theory with respect to getting data from a source and producing valuable insights from the same.		
1	Extracting data from various sources, like SQL databases, JSON, CSV, XML, and text files(Data Acquisition)		
2	Creating data frames and performing basic operations on data frames using pandas and numpy.(Data Preprocessing and Preparation)		
3	Handling missing data, merging, joining ,concatenating, reducing columns(Data Quality and transformation)		
4	Data Analysis in Excel		
5	EDA in Python		
6	Data visualization using Pandas, Seaborn, Mathplotlib - I		
7	Data visualization using Pandas, Seaborn, Mathplotlib - II		
8	Example for Data Story telling		

Course Code	Course Title	Credits	Lectures / Week
	Advanced Statistical Methods	3	5
<p>About the Course: This course is designed to provide learners with an understanding of the data and to develop an understanding of the quantitative techniques from Statistics. It also provides the knowledge of different statistical tools used for primary statistical analysis of data.</p>			
<p>Course Objectives:</p> <ul style="list-style-type: none"> • To make learner enable to find the correlation between different variables and further apply the regression analysis to find the exact relation between them. • To develop ability to analyze statistical data through R software. • To learn computational skills to implement various statistical inferential approaches. 			
<p>Learning Outcomes: After successful completion of this course, learners would be able to</p> <ul style="list-style-type: none"> • Study the relationship between variables using techniques of correlation and regression. • Calculate probability, conditional probability and independence. • Apply the given discrete and continuous distributions whenever necessary. 			
Unit-I	<p>Analysis of Variance: Introduction, Uses, Cochran's Theorem (Statement only). One way classification with equal & unequal observations per class, Two way classification with one observation per cell. Mathematical Model, Assumptions, Expectation of various sums of squares, Ftest, Analysis of variance table. Least square estimators of the parameters, Variance of the estimators, Estimation of treatment contrasts, Standard Error and Confidence limits for elementary treatment contrasts. Fitting of curves: Least square method. Fitting of the straight line $y = a + bx$, parabolic curve $y = a + bx + cx^2$</p>		12
Unit-II	<p>Non-parametric tests: need of non-parametric tests, sign test, Wilcoxon's signed rank test, run test, Kruskal-Walis tests.</p>		12

	Chi square test:- Test of goodness of fit and independence of attributes,Contingency table.	
Unit-III	<p>Simple linear regression model</p> <p>Assumptions of the model, Derivation of ordinary least square (OLS) estimators of regression coefficients for simple, Properties of least square estimators (without proof), Coefficient of determination R² and adjusted R² ,</p> <p>Procedure of testing</p> <p>a) Overall significance of the models</p> <p>b) Significance of individual coefficients</p> <p>c) Confidence intervals for the regression coefficients</p> <p>Data Pre-processing: Detection and treatment of missing value(s)and outliers, Variable selection and Model building, Interpretation of output produced by lm command in R. Weighted Least Square Method, Polynomial Regression Models.</p>	12
Unit-IV	<p>Multiple linear regression model</p> <p>Derivation of ordinary least square (OLS) estimators of regression coefficients for multiple regression models, Coefficient of determination R² and adjusted R² ,</p> <p>Procedure of testing</p> <p>a) Overall significance of the models</p> <p>b) Significance of individual coefficients</p> <p>c) Confidence intervals for the regression coefficients</p> <p>Data Pre-processing: Detection and treatment of missing value(s) and outliers, Variable selection and Model building, Interpretation of output produced by lm command in R.</p>	12
Unit-V	<p>Time Series</p> <p>Definition of time series .Its component. Models of time series.</p>	12

	<p>Estimation of trend by: i) Freehand curve method ii) method of semi average iii) Method of Moving average iv) Method of least squares(linear trend only)</p> <p>Estimation of seasonal component by i) method of simple average ii) Ratio to moving average iii) Ratio to trend method .</p> <p>Index Numbers</p> <p>a) Index numbers as comparative tool. Stages in the construction of Price Index Numbers.</p> <p>b) Measures of Simple and Composite Index Numbers. Laspeyre's, Paasche's, Marshal-Edgeworth's, Dobisch & Bowley's and Fisher's Index Numbers formula.</p> <p>c) Quantity Index Numbers and Value Index Numbers Time reversal test, Factor reversal test, Circular test.</p> <p>d) Fixed base Index Numbers, Chain base Index Numbers. Base shifting, splicing and deflating.</p> <p>e) Cost of Living Index Number. Concept of Real Income based on Wholesale Price Index Number</p>	
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Text Book:

1. Trivedi, K.S.(2009) : Probability, Statistics, Design of Experiments and Queuing theory, with applications of Computer Science, Prentice Hall of India, New Delhi

Additional References:

1. Ross, S.M. (2006): A First course in probability. 6th Edⁿ Pearson
2. Kulkarni, M.B., Ghatpande, S.B. and Gore, S.D. (1999): Common statistical tests. Satyajeeet Prakashan, Pune
3. Gupta, S.C. and Kapoor, V.K. (2002) : Fundamentals of Mathematical Statistics, S. Chand and Sons, New Delhi
4. Gupta, S.C. and Kapoor, V.K. (4th Edition) : Applied Statistics, S. Chand and Son's, New Delhi
5. Montgomery, D.C. (2001): Planning and Analysis of Experiments, Wiley.

Course Code	Course Title	Credits	Practical/ Tutorials Per Week
	Practical of Advanced Statistical Methods	1	3

1.	Analysis of Variance
2.	Examples based on fitting a Straight Line & Examples based on fitting a Second degree parabola
3.	Non parametric tests- I
4.	Non parametric tests- II
5.	Simple linear regression model-I
6.	Simple linear regression model-II
7.	Multiple linear regression model-I
8.	Multiple linear regression model-II
9.	Time Series
10.	Index Number

Course Code	Course Title	Credits	Lectures / Week
VESUS DS??	Data Warehousing and Data Mining	3	5
<p>About the course To help learners learn data warehousing and mining architecture , understanding classification and prediction of data.</p>			
<p>Course Objectives The objectives of this course are:</p> <ul style="list-style-type: none"> ● To understand the principles of Data warehousing and Data Mining. ● To be familiar with the Data warehouse architecture and its Implementation. ● To know the Architecture of a Data Mining system. ● To understand the various Data preprocessing Methods. ● To perform classification and prediction of data. 			
<p>Learning Outcomes After successful completion of this course -</p> <ul style="list-style-type: none"> ● Learners will be able to understand the importance of advanced database concepts. ● earners will develop skills for implementation of mining the data. ● Learners will be able to understand the implementation of various data preprocessing methods 			
Unit	Topic	No. of lectures	
I	Types of Data Database Data Data Warehouses -Introduction, DW Design, Data Marts, Inmon's Methodology, Kimball's Methodology, Dimensional Design, DW Components,Building Data Warehousing Components, Data Warehouse Architecture,Data Extraction Cleanup and Transformation Tools.OLAP and multidimensional analysis	12	

	<p>Star Schema, Dimension Tables, Keys and History, Fact Tables, Surrogate Keys vs Natural Keys, Rich Dimensions, Slowly Changing Dimensions (Type 1, 2, 3, Hybrid), Multiple Stars, Conformed Dimensions, Snowflakes, Outriggers, OLAP Cubes, 3D, Hypercubes, Slicing, Dicing, Drill Up / Down, Rollup, Pivot Variations of Cube Architectures: MOLAP Cubes, ROLAP Cubes, HOLAP Cubes, WOLAP Cubes, DOLAP Cubes, ROLAP Cubes , Transactional Data Other Kinds of Data</p>	
II	<p>Preprocess the Data. Major Tasks in Data Preprocessing. Data Cleaning Missing Values Noisy Data Data Cleaning as a Process Data Integration Data Transformation Data Reduction Data Discretization Architecture of a Data Mining System and Classification of a Data Mining System</p> <p>Data mining: History, strategies, techniques, applications, challenges of data mining, Future of data mining. Types of Data Database Data Data Warehouses. Transactional Data. Other Kinds of Data</p> <p>Classification and Prediction: - Issues Regarding Classification and Prediction – Classification by Decision Tree Introduction – Bayesian Classification – Rule Based Classification – Classification by Backpropagation – Support Vector Machines – Associative Classification – Lazy Learners – Other Classification Methods – Prediction – Accuracy and Error Measures – Evaluating the Accuracy of a Classifier or Predictor – Ensemble Methods – Model Section.</p>	12
III	<p>Data Mining: - Data Mining Functionalities – Data Preprocessing – Data Cleaning – Data Integration and Transformation – Data Reduction – Data Discretization and Concept Hierarchy Generation- Architecture Of A Typical Data Mining Systems- Classification Of Data Mining Systems.</p> <p>Association Rule Mining: - Efficient and Scalable Frequent Item set Mining Methods – Mining Various Kinds of Association Rules – Association Mining to Correlation Analysis – Constraint-Based Association Mining.</p> <p>Data mining definitions and process: business and data understanding. Association Analysis: Definition of association rule, General issues: Support; Confidence; Lift; Conviction, Frequent Item sets: APriori Algorithm; Issues with APriori Algorithm, Data structures: Hash tree and FP tree</p>	12

IV	Data Warehouse Differences between Operational Database Systems and Data Warehouses Enterprise Warehouse, Data Mart, and Virtual Warehouse Cluster Analysis: - Types of Data in Cluster Analysis – A Categorization of Major Clustering Methods – Partitioning Methods – Hierarchical methods – Density-Based Methods – Grid-Based Methods – Model-Based Clustering Methods – Clustering High-Dimensional Data – Constraint-Based Cluster Analysis – Outlier Analysis.	12
V	Mining object , spatial data mining, multimedia data mining, Multidimensional Analysis and Descriptive Mining of Complex Data Objects – Spatial Data Mining – Multimedia Data Mining – Text Mining – Mining the World Wide Web.	12

TextBooks :

Additional References:

1. Jiawei Han, Micheline Kamber and Jian Pei“Data Mining Concepts and Techniques”, Third Edition, Elsevier, 2011.
2. Alex Berson and Stephen J. Smith “Data Warehousing, Data Mining & OLAP”, Tata McGraw – Hill Edition, Tenth Reprint 2007.
3. K.P. Soman, Shyam Diwakar and V. Ajay “Insight into Data mining Theory and Practice”, Easter Economy Edition, Prentice Hall of India, 2006.
4. Building the Data Warehouse, Inmon: Wiley (1993).
5. Data Mining: Introductory and Advanced Topics, Dunham, Margaret H, Prentice Hall (2006)

Course Code	Course Title	Credits	Practical/ Tutorials Per Week
	Practicals in Data Warehousing and Data Mining	1	3
1	Basic of WEKA Installing WEKA , understanding WEKA data file format ,		
2	Data visualization in WEKA Data filtering Using the concepts of data mining with WEKA		
3	Create tables using different applications and to pre-process data imported from external sources .		

4	Develop an application to design a warehouse by importing various tables from external sources
5	Execute K-Means Clustering using Weka.
6	Pre-process the given data set and hence apply hierarchical algorithms And density based clustering techniques. Interpret the result.
7	Develop an application to create a fact table and measures in a cube.
8	Develop an application to create dimension tables in a cube and form star schema
9	Develop an application to demonstrate processing and browsing data from a cube.
10	Implement Data Mining using Python.

Course Code	Course Title	Credits	Lect/Week
	IoT	3	5
<p>About the course The course aims to provide basic understanding of SoC architectures; IoT, different types of IoT platforms and different types of applications that can be built.</p>			
<p>Course Objectives The objectives of this course are:</p> <ul style="list-style-type: none"> ● Introduce concepts of SoC and IoT ● Introduce various types of IoT platforms ● Interfacing various types of devices using different protocols with IoT ● Understand practical applications of IoT in real life world 			
<p>Learning Outcomes After successful completion of this course -</p> <ul style="list-style-type: none"> ● learners will be able to understand SoC and IoT ● Learners will be use different types of IoT Platforms and interfaces ● Learners will be able to use various types of sensors with IoT platforms ● Learners will get an idea of various types of applications built using IoT 			
Unit	Topic	No. of lectures	
I	<p>SoC and Raspberry Pi System on Chip: What is System on chip? Structure of System on Chip. SoC products: FPGA, GPU, APU, Compute Units. ARM 8 Architecture: SoC on ARM 8. ARM 8 Architecture Introduction</p> <p>Fundamentals of IoT: Introduction, Definitions & Characteristics of IoT, IoT Architectures, Physical & Logical Design of IoT, Enabling Technologies in IoT, History of IoT, About Things in IoT, The Identifiers in IoT, About the Internet in IoT, IoT frameworks, IoT and M2M.</p>	12	

<p>II</p>	<p>Introduction to Raspberry Pi: Introduction to Raspberry Pi, Raspberry Pi Hardware, Preparing your raspberry Pi. Raspberry Pi Boot: Learn how this small SoC boots without BIOS. Configuring boot sequences and hardware.</p> <p>Programming Raspberry Pi Raspberry Pi and Linux: About Raspbian, Linux Commands, Configuring Raspberry Pi with Linux Commands</p> <p>Raspberry Pi Interfaces: UART, GPIO, I2C, SPI Useful Implementations: Pulse Width Modulation, SPI for Camera.</p>	<p>12</p>
<p>III</p>	<p>Sensors Networks : Definition, Types of Sensors, Types of Actuators, Examples and Working,</p> <p>Sensors- Light sensor, temperature sensor with thermistor, voltage sensor, ADC and DAC, Temperature and Humidity Sensor DHT11, Motion Detection Sensors, Wireless Bluetooth Sensors, Level Sensors, USB Sensors, Embedded Sensors, Distance Measurement with ultrasound sensor, RFID Principles and components,</p> <p>Controlling Hardware- Connecting LED, Buzzer, Switching High Power devices with transistors, Controlling AC Power devices with Relays, Controlling servo motor, speed control of DC Motor, unipolar and bipolar Stepper motors</p>	<p>12</p>
<p>IV</p>	<p>IoT and Protocols IoT Security: HTTP, UPnp, CoAP, MQTT, XMPP. IoT Service as a Platform: Node RED. M2M vs. IOT Communication Protocols</p> <p>Basics of Wireless Networking Introduction to ESP8266 Wi-Fi Module Various Wi-Fi library Web server- introduction, installation, configuration Posting sensor(s) data to web server</p>	<p>12</p>
<p>V</p>	<p>Applications of IoT: Home Automation, Smart Cities, Energy, Retail Management, Logistics, Agriculture, Health and Lifestyle, Industrial IoT, Legal challenges, IoT design Ethics, IoT in Environmental Protection.</p>	<p>12</p>

TextBooks :

- 1) Learning Internet of Things, Peter Waher, Packt Publishing(2015)
- 2) Mastering the Raspberry Pi, Warren Gay, Apress(2014)

Additional References:

- 1) Abusing the Internet of Things, Nitesh Dhanjani, O'Reilly
- 2) Internet Of Things: A Hands-On Approach Paperback – 1 January 2015 by Arsheep Bahga (Author), Vijay Madiseti (Author)

3)Arduino, Raspberry Pi, NodeMCU Simple projects in easy way by Anbazhagan k and Ambika Parameswari k | 24 August 2019

Course Code	Course Title	Credits	Practical/Tutorials Per Week
	IoT	1	3
1	Preparing Raspberry Pi: Hardware preparation and Installation		
2	Linux Commands: Exploring the Raspbian		
3	GPIO: Light the LED with Python with/without a button		
4	SPI: Camera Connection and capturing Images using SPI		
5	GPIO: LED Grid Module: Program the 8X8 Grid with Different Formulas		
6	Stepper Motor Control: PWM to manage stepper motor speed.		
7	Node RED: Connect LED to Internet of Things		
8	Use different types of sensors with Raspberry Pi.		
9	Trigger a set of led Gpios on the pi via a Python Flask web server		
10	. Interface with an Accelerometer Gyro Mpu6050 on the i2c bus and send sensor values over the internet via mqtt.		

SYBSc

Semester IV

Course Code	Course Title	Credits	Lect/Week
	Object Oriented Programming using Java	3	5
About the course			
Course Objectives The objectives of this course are: <ul style="list-style-type: none">• The objective of this course is to teach the learner how to use Object Oriented paradigm to develop code and understand the concepts of Core Java and to cover-up with the pre-requisites of Core java			
Learning Outcomes <ul style="list-style-type: none">• This subject will help to improve the analytical skills of object oriented programming• Overall development of problem solving and critical analysis• Formal introduction to Java programming language			
Unit	Topic	No. of lectures	

I	OOP concepts: Classes and objects, data abstraction, encapsulation, inheritance, benefits of inheritance, polymorphism, procedural and object oriented programming paradigm. Introduction to Java : Basics of Java programming, Data types, Variables, Operators, Control structures including selection, Looping, Java methods, Arrays in java.	12
II	Objects and Classes : Basics of objects and classes in java, Constructors, Declaring Methods	12
III	Inheritance hierarchies, super and subclasses, member access rules, super keyword, preventing inheritance: final classes and methods, the object class and its methods; Constructors in	12
IV	Inheritance Polymorphism: dynamic binding, method overriding, abstract classes and methods; Interface: Interfaces VS Abstract classes, defining an interface, implement interfaces, accessing implementations through interface references, extending interface;	12
V	Exception Handling: Introduction, Pre-Defined Exceptions, Try-Catch-Finally, Throws, throw, User Defined Exception examples	12
<p>TextBooks : Herbert Schildt, Java The Complete Reference, Ninth Edition, McGraw-Hill Education, 2014</p> <p>Additional References:</p> <p>1) E. Balagurusamy, Programming with Java, Tata McGraw-Hill Education India, 2014</p> <p>2) Programming in JAVA, 2nd Ed, Sachin Malhotra & Saurabh Choudhary, Oxford Press</p>		

Course Code	Course Title	Credits	Practical/ Tutorials Per Week
	Practical of Object Oriented Programming using Java	1	3
1	Program to define the data types, variable, operators,		
2	Program to define control structures and. arrays		
3	Program to define class, methods and objects.		

4	Program to define class and constructors. Demonstrate constructors
5	Demonstrate method overloading
6	Program to define inheritance and show method overriding
7	Program to demonstrate Abstraction
8	Program to demonstrate Exception Handling.

Course Code	Course Title	Credits	Lect/Week
	AI & Machine Learning	3	5
<p>About the course:</p> <ul style="list-style-type: none"> ● To understand the basic theory underlying machine learning. ● To be able to formulate machine learning problems corresponding to different applications. To understand a range of machine learning algorithms along with their strengths and weaknesses. ● To be able to apply machine learning algorithms to solve problems of moderate complexity. ● To apply the algorithms to a real-world problem, optimize the models learned and report on the expected accuracy that can be achieved by applying the models 			
<p>Course Objectives The objectives of this course are:</p> <ul style="list-style-type: none"> ● Appreciate the importance of visualization in the data analytics solution ● Apply structured thinking to unstructured problems ● Understand a very broad collection of machine learning algorithms and problems ● Learn algorithmic topics of machine learning and mathematically deep enough to introduce the required theory ● Develop an appreciation for what is involved in learning from data. 			

Learning Outcomes

After successful completion of this course -

- Learner will be able to understand concepts of AI
- Learner will get to know different types of machine algorithms
- Learner will be able to solve different types of problems of this domain

Unit	Topic	No. of lectures
I	What Is AI: Foundations, History and State of the Art of AI. Intelligent Agents: Agents and Environments, Nature of Environments, Structure of Agents. Problem Solving by searching: Problem-Solving Agents, Example Problems, Searching for Solutions, Uninformed Search Strategies, Informed (Heuristic) Search Strategies, Heuristic Functions.	12
II	Foundations for Machine Learning- ML Techniques overview , How ML is related to AI, Types of ML Regression and its various types, Validation Techniques (Cross-Validations) , Feature Reduction/Dimensionality reduction Principal components analysis (Eigen values, Eigen vectors, Orthogonality)	12
III	Classification Models - Nearest Neighbor method, Naïve Bayes Classifier, logistic regression, decision tree, SVM, Ensemble Methods	12
IV	Unsupervised Learning - Clustering, K-Means, EM, Association Rule Mining, Anomaly Detection, Apriori Algorithm	12
V	Time Series, Hidden Markov Model, Introduction to neural networks	12

TextBooks :

- 1) Artificial Intelligence: A Modern Approach, Stuart Russell and Peter Norvig,3rd Edition, Pearson, 2010.
- 2) Artificial Intelligence | Third Edition | By Pearson: A Modern Approach by Russell

Additional References:

1. The Elements of Statistical Learning, Trevor Hastie, Robert Tibshirani and Jerome Friedman, Springer, 2013

2. Artificial Intelligence: Foundations of Computational Agents, David L Poole, Alan K. Mackworth, 2nd Edition, Cambridge University Press ,2017.

Course Code	Course Title	Credits	Practical/ Tutorials Per Week
	Practical of AI & Machine Learning	1	3
1	Implement BFS & DLS Algorithm		
2	Implement A* Algorithm		
3	Example of Regression, Logistic Regression , Cross Validation		
4	Example of Naive-Bayes		
5	Example of Decision Tree, Regression Tree		
6	Example of SVM		
7	Example of Ensemble Method		
8	Example of K-Means		
9	Example of Hidden Markov Model		
10	Example of Neural Network		

Course Code	Course Title	Credits	Lectures / Week
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VESUS DS??	Software Engineering	3	5
<p>About the course To help learners learn data warehousing and mining architecture , understanding classification and prediction of data.</p>			
<p>Course Objectives The objectives of this course are:</p> <ul style="list-style-type: none"> ● The basic objective of software engineering is to develop methods and procedures for software development that can scale up for large systems. ● It can be used consistently to produce high-quality software at low cost and with a small cycle of time. ● To understand the importance of Software Testing strategies and Quality Assurance during the software development process. 			
<p>Learning Outcomes After successful completion of this course -</p> <ul style="list-style-type: none"> ● Apply use of knowledge of Software Life Cycle to successfully implement the projects in the corporate world ● Identify the Inputs, Tools and techniques to get the required Project deliverable and Product deliverable using knowledge areas of Project Management. ● Understand the concept and need of software testing ● Understand the need and usage of software tools required for manual and automated testing 			
Unit	Topic	No. of lectures	
I	<p>Introduction: The Nature of Software, Software Engineering, The Software Process, Generic Process Model, The Waterfall Model, Incremental Process Models, Evolutionary Process Models, Concurrent Models, Component-Based Development, The Unified Process Phases, Agile Development- Agility, Agile Process, Extreme Programming. Software Requirement Analysis and Specification Requirement Engineering Process: Elicitation, Analysis, Documentation, Review and Management of User Needs, Feasibility Study, Entity Relationship Diagrams, DaSRS Document, IEEE Standards for SRS. Requirement Elicitation: Interviews, Questionnaire, Brainstorming, Facilitated Application Specification Technique (FAST)</p>		

<p>II</p>	<p>UML -Use Case Approach Sequence diagram, Collaboration diagram, State chart diagram, Activity diagram, Component diagram, Deployment diagram . SRS Case study.</p> <p>Software Project Planning and Scheduling Business Case, Project selection and Approval, Project charter, Project Scope management: Scope definition and Project Scope management, Creating the Work Breakdown Structures, Scope Verification, Scope Control. Staffing Level Estimation, Effect of schedule Change on Cost, Degree of Rigor & Task set selector, Project Schedule, Schedule Control</p>	
<p>III</p>	<p>System Design: System/Software Design, Architectural Design, Low-Level Design Coupling and Cohesion, Functional-Oriented Versus The Object-Oriented Approach, Design Specifications, Verification for Design, Monitoring and Control for Design Software Measurement and Metrics: Product Metrics – Measures, Metrics, and Indicators, Function-Based Metrics, Metrics for Object-Oriented Design, Operation-Oriented Metrics, User Interface Design Metrics, Metrics for Source Code, Halstead Metrics Applied to Testing, Metrics for Maintenance, Cyclomatic Complexity, Software Measurement - Size-Oriented, Function-Oriented Metrics, Metrics for Software Quality.</p> <p>Estimation in Project Planning Process –Software Scope And Feasibility, Resource Estimation, Empirical Estimation Models – COCOMO II, Estimation for Agile Development, The Make/Buy Decision, Project Scheduling - Basic Principles, Relationship Between People and Effort, Effort Distribution, Time-Line Charts</p>	
<p>IV</p>	<p>Software Testing and Quality Assurance Testing Objectives, Unit Testing, Integration Testing, Acceptance Testing, Regression Testing, Testing for Functionality and Testing for Performance, TopDown and Bottom-Up Testing Strategies: Test Drivers and Test Stubs, Structural Testing (White Box Testing), Functional Testing (Black Box Testing), Test Data Suit Preparation, Alpha and Beta Testing of Products. Static Testing Strategies: Formal Technical Reviews (Peer Reviews), Walk Through, Code Inspection, Compliance with Design and Coding Standards Software Quality Assurance (SQA): Verification and Validation, SQA Plans, Software Quality Frameworks, ISO 9000 Models, SEI-CMM Model.</p>	

V	<p>Software Maintenance and Software Project Management Software as an Evolutionary Entity, Need for Maintenance, Categories of Maintenance: Preventive, Corrective and Perfective Maintenance, Cost of Maintenance, Software Re- Engineering, Reverse Engineering. Software Configuration Management Activities.</p> <p>Risk Management - Software Risks, Risk Identification, Risk Projection and Risk Refinement.</p>	
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TextBooks :

1) Software Engineering, A Practitioner’s Approach, Roger S, Pressman.(2014)

Additional Reference(s):

1) Software Engineering, Ian Sommerville, Pearson Education

2) Software Engineering: Principles and Practices”,Deepak Jain,OXFORD University Press,

3) Fundamentals of Software Engineering, Fourth Edition, Rajib Mall, PHI

4) Software Engineering: Principles and Practices, Hans Van Vliet, John Wiley & Sons

5) A Concise Introduction to Software Engineering, Pankaj Jalote, Springer

Course Code	Course Title	Credits	Practical/ Tutorials Per Week
	Practical of Software Engineering	1	3
1	Develop a Use Case Diagram for the given case study		
2	Develop an Activity Diagram and E-R Diagram for given the case study.		
3	Develop a Class Diagram and State Chart Diagram for the given case study.		
4	Develop a Sequence / Collaboration Diagram for the given case study.		
5	Develop a Component and Deployment Diagram for the given case study.		
6	Configure Selenium for Software Automation Testing using Java.		

7	Configure Selenium for Software Automation Testing using Python.
8	Write a Selenium script using Java/Python to open a web-page using Mozilla Firefox and find out the number of links on the page.
9	Write and test a program to provide a total number of objects present / available on the page.
10	Write a Selenium script using Java/Python to open a web-page using Google Chrome to login a specific web page

Course Code	Course Title	Credits	Lect/Week
	Cloud Computing	3	5
About the course			
Course Objectives The objectives of this course are: <ul style="list-style-type: none"> ● To understand the concepts in Cloud Computing and its Security ● To understand the evolving computer model. ● To introduce the various levels of services that can be achieved by cloud 			
Learning Outcomes After successful completion of this course - <ul style="list-style-type: none"> ● To explain and apply levels of services of cloud ● To describe the security aspects in the cloud. 			
Unit	Topic	No. of lectures	
I	Cloud Computing Foundation: Introduction to Cloud Computing – Move to Cloud Computing – Types of Cloud – Working of Cloud Computing	12	
II	Cloud Computing Architecture : Cloud Computing Technology – Cloud Architecture – Cloud Modeling and Design - Virtualization : Foundation – Grid, Elements of Parallel Computing. Elements of	12	

	Distributed Computing. Cloud and Virtualization – Virtualization and Cloud Computing	
III	Data Storage and Cloud Computing : Data Storage – Cloud Storage, Cloud Computing and Security : Risks in Cloud Computing – Data Security in Cloud – Cloud Security Services– Application Security – Virtual Machine Security - Identity Management and Access Control, Disaster Recovery in Clouds.	12
IV	Introduction to OpenStack, OpenStack test-drive, Basic OpenStack operations, OpenStack CLI and APIs, Tenant model operations, Quotas, Private cloud building blocks, Controller deployment, Networking deployment, Block Storage deployment, Compute deployment, deploying and utilizing OpenStack in production environments, Building a production environment, Application orchestration using OpenStack Heat	12
V	Cloud Applications – Moving Applications to the Cloud – Microsoft Cloud Services – Google Cloud Applications – Amazon Cloud Services – Cloud Applications	12

TextBooks : A.Srinivasan and J.Suresh, “Cloud Computing – A Practical Approach for Learning and Implementation”, Pearson India Publications 2014.

Additional References:

1. Rajkumar Buyya, James Broberg, Andrzej , “Cloud Computing: Principles and Paradigms”, Wiley India Publications 2011.
2. Arshdeep Bahga and Vijay Madiseti ,“Cloud Computing – A Hands on Approach”, Universities Press (India) Pvt Ltd. 2014.

Course Code	Course Title	Credits	Practical/ Tutorials Per Week
	Practical of Cloud Computing	1	3

1	Working and Implementation of Infrastructure as a service.
2	Working and Implementation of Software as a service.
3	Working and Implementation of identity management.
4	Practical Implementation of cloud security.
5	Execute the step to Demonstrate and implementation of cloud on single sign on
6	Write a program for web feed.
7	Working and Implementation of Platform as a services.
8	Install Google App Engine. Create hello world app and other simple web applications using python/java.
9	Install hadoop in the system.
10	To write a word count program to demonstrate the use of Map and Reduce task.

Course Code	Course Title	Credits	Lectures / Week
	Mobile Programming	3	5

About the course

This course is intended to study the basics of Mobile technology. During this course the learner will explore various aspects of Mobile technology like application in various domains.

Course Objectives

The objectives of this course are:

- To provide comprehensive insight into developing applications running on smart mobile devices and demonstrate programming skills for managing tasks on mobile.
- To provide systematic approach for studying definition, methods and its applications for Mobile-App development

Learning Outcomes

After successful completion of this course -

- Understand the requirements of the Mobile programming environment.
- Learn about basic methods, tools and techniques for developing Apps
- Explore and practice App development on Android Platform
- Develop working prototypes of working systems for various uses in daily lives

Unit	Topic	No. of lectures
I	<p>Introduction to Android: What is Android? Setting up development environment, Dalvik Virtual Machine & .apk file extension,</p> <p>Basic Building blocks - Activities, Services, Broadcast Receivers & Content providers</p> <p>UI Components - Views</p> <p>Components for communication -Intents & Intent Filters, Android API levels (versions & version names)</p> <p>Application Structure: AndroidManifest.xml, uses-permission & uses-sdk, Resources & R.java o Assets, Layouts & Drawable Resources, Activities and Activity lifecycle</p>	12
II	<p>Basic UI design: Form widgets, Text Fields, Layouts [dip, dp, sip, sp] versus px</p> <p>UI Views: Time and Date, Images and media, Composite, AlertDialogs & Toast,Popup TextView, Button, ImageButton,</p>	12

	<p>EditText, CheckBox, ToggleButton, RadioButton, and RadioGroup Views, ProgressBar View, TimePicker View, DatePicker View,</p> <p>Intents: Explicit Intent, Implicit Intent</p>	
III	<p>Adapters: ArrayAdapter, BaseAdapters. ListView and ListActivity, Custom listview, GridView using adapters, Gallery using adapters, Spinner View, AutoCompleteTextView</p> <p>Menu: Option Menu, Context Menu, Sub Menu</p> <p>Screen Navigation: Using Drawer Layout and Using Tab and TabActivity</p> <p>Styles & Themes: styles.xml, drawable resources for shapes, gradients (selectors), style attribute in layout file, Applying themes via code and manifest file</p>	12
IV	<p>AsyncTask and AsyncTaskLoader, connecting to the Internet, Broadcast receivers, Services, Notifications, Alarm managers, Transferring data efficiently</p> <p>Data - saving, retrieving, and loading: Overview to storing data, Shared preferences, SQLite primer, store data using SQLite database, Content Providers.</p>	12
V	<p>Advanced: Live Folders, Using Sd cards, XML Parsing, JSON Parsing, Maps, GPS, Location based Services, Accessing Phone services (Call, SMS, MMS)</p> <p>Permissions, performance and security, Firebase and AdMob</p>	12
<p>TextBooks :</p> <ol style="list-style-type: none"> 1. “Beginning Android 4 Application Development”, Wei-Meng Lee, March 2012, WROX. <p>Additional References:</p> <ol style="list-style-type: none"> 1. https://developers.google.com/training/courses/android-fundamentals 2. https://www.gitbook.com/book/google-developer-training/android-developer-fundamental-course-practicals/details 		

Course Code	Course Title	Credits	Practical/ Tutorials Per Week
	Practical of Mobile Programming	1	3
1	Introduction to Android, Introduction to Android Studio IDE, Application Fundamentals: Creating a Project, Android Components, Activities, Services, Content Providers, Broadcast Receivers, Interface overview, Creating Android Virtual device, USB debugging mode, Android Application Overview. Simple “Hello World” program.		
2	Programming Resources Android Resources: (Color, Theme, String, Drawable, Dimension, Image),		
3	Programming Activities and fragments Activity Life Cycle, Activity methods, Multiple Activities, Life Cycle of fragments and multiple fragments.		
4	Programs related to different Layouts Coordinate, Linear, Relative, Table, Absolute, Frame, List View, Grid View.		
5	Programs on Intents, Events, Listeners and Adapters the Android Intent Class, Using Events and Event Listeners		
6	Create an android app that demonstrates the use of an Options Menu.		
7	Create an android app that demonstrate Screen Navigation Using the App Bar.		
8	Create an android app to Connect to the Internet and use Broadcast Receiver.		
9	Database Programming with SQLite		
10	Programming Media API and Telephone API		

Vivekanand Education Society's
College of Arts, Science & Commerce
(Autonomous)



Proposed Syllabus

For the

Program: T.Y.B.Sc. Sem - V & VI

CBCS Course:
BSc DATA SCIENCE & DATA ANALYTICS

(Choice Based and Credit System with effect
from the academic year 2024-25)

TYBSc

Semester V

Course Code	Course Title	Credits	Lectures / Week
	Data Analytics and Visualization	3	5

About the course

To help learners learn data warehousing and mining architecture , understanding classification and prediction of data.

Course Objectives

The objectives of this course are:

- Students should be able to display data using appropriate visualization techniques (e.g., x-y line plots, bar charts, pie charts, scatter plots, histograms).
- Students should be able to understand and use basic statistical indicators (e.g., mean, median, standard deviation, maximum, minimum, tests of significance).
- Students should be able to apply built-in functions (e.g., sum, difference, log, exponential) appropriately and in context.
- Students should be able to use variables, conditionals, loops, functions, and logical indexing in scripts to analyze data.
- Students should be able to choose appropriate methods to solve problems.
- Students should be able to draw conclusions and formulate hypotheses from data presented graphically.
- Students should be able to write scripts that handle different types of data.
- Students should use models to generate data to study scientific questions.
- Students should be able to communicate their results in a clear and correct manner.

Learning Outcomes

After successful completion of this course -

- Understand the fundamental design principles and different types of data visualization.**
- 2. Identify both positive and negative impacts of data-informed decisions across a variety of domains.**
- 3. Apply the fundamental concepts of data visualization to define a project in your field of study.**
- 4. Practice the core principles using widely available tools (e.g. Tableau).**
- 5. Demonstrate the best practice that presents your story in the process of creating data visualization including connecting to different data sources, assessing the quality of the data, and converting raw data into data visualizations that provide actionable information.**

Unit	Topic	No. of

		lectures
I	What is Data Visualization? Interesting Data Visualization examples and creators - ggplot2 - 2D plotting Relationship plots, Working of Visualization using Tableau, R , comparison.	12
II	Structured Problem Solving using Frameworks, Data Storytelling Various case studies on Data Visualization, Data Modeling	12
III	Advanced SQL and Best Practices Introduction to Big Data and Cloud Analytics using Spark Big Data Case Study Data Structures - Sets, Dictionaries, Stacks, Queues Searching and Sorting Algorithm Analysis + Recursion, Capstone Project	12
IV	Environment Setup, Pandas-Series, Pandas-DataFrames, Pandas Panel Pandas-Basic Functionality, Descriptive Analysis, Function Application Pandas Reindexing, Pandas Iteration, Pandas Sorting, Working with Text Data, Option and Customization, Indexing and Selecting Data, Statistical Function, Pandas Window Function, Pandas Aggregations, Pandas Missing Data. Pandas GroupBy, Pandas Merging/Joining, Pandas Concatenation, Pandas Date Functionality, Pandas Timedelta, Pandas Categorical Data, Visualization using Pandas, Pandas IO Tools, Pandas Sparse Data, Pandas Caveats & Gotchas, Comparison with SQL	12
V	Introduction to NumPy, Getting started with Numpy Arrays, Numpy Random, Numpy ufunc, Charts and graphs, Matplotlib, basic calculations Various function, Vlookup(),Hlookup(),Xlookup() Introducing to Tableau, Managing Data Sources and Visualizations , Managing Tableau Worksheets and Workbooks, Creating Custom Calculations and Fields, Analyzing Data, Sorting and Filtering Data Defining Group and Sets, Creating Basic Visualizations, Formatting Tableau Visualizations, Annotating and Formatting Visualization Mapping Geographical Data, Creating Dashboards and Actions Study of various case studies	12

TextBooks :

1. Allen Downey, Jeff Elkner and Chris Meyers, (2017), How To Think Like A Computer Scientist: Learning With Python, DreamTech
2. Wesley J Chun, (2018), Core Python Programming, Prentice Hall 3) Lutz and David Ascher, (2016), Learning Python, O'Reilly

Additional References

1. Storytelling with Data: A Data Visualization Guide for Business Professionals

Course Code	Course Title	Credits	Practical/ Tutorials Per Week
	Practical of Data Analytics & Visualization	1	3
1	Operations using Libraries for data analytics Anaconda, Numpy, Scipy, Pandas,		
2	Matplotlib, Seaborn, bokeh, Scikit-learn, Jupyter Notebook: Create Documentation, Code mode, Markdown mode		
3	Mean, Median, Mode, Z-scores, Bias -variance dichotomy, Sampling and t-tests, Sample vs Population statistics, Random Variables		
4	Probability distribution function, Expected value, Binomial Distributions, Normal Distributions, Central limit Theorem,		
5	Hypothesis testing, Z-Stats vs T-stats, Type 1 type 2 error, Chi Square test ANOVA test and F-stats		
6	NUMPY: Creating NumPy arrays, Indexing and slicing in NumPy, Downloading and parsing data, creating multidimensional arrays, NumPy Data types, Array tributes, Indexing and Slicing, creating array, views copies, Manipulating array shapes I/O,		
7	SCIPY: Introduction to SciPy, Create function, modules of SciPy		
8	MATPLOTLIB: Scatter plot, Bar charts, histogram, Stack charts, Legend title Style, Figures and subplots,		
9	Learn plotting functions in pandas, Labeling and arranging figures, Save plots		
10	Compare any of the problems given above using R and Tableau.		

Course Code	Course Title	Credits	Lect/Week
	Cyber Security	3	4
<p>About the course This course is designed to understand the ethics, legality, methodologies and techniques of cyber security</p>			
<p>Course Objectives This course provides the foundation for understanding the key issues associated with protecting information assets. The purpose of the course is to provide the student with an overview of the field of information security and assurance.</p>			
<p>Learning Outcomes After successful completion of this course -</p> <ul style="list-style-type: none"> ● Understand the broad set of technical, social & political aspects of Cyber Security. ● Appreciate the vulnerabilities and threats posed by criminals, terrorist and nation states to national infrastructure. ● Understand the importance of ethical hacking tool. ● Understanding the ethical hacking process. ● Implementing ethical hacking tools in an organization. ● Apply security principles to system design. ● Apply methods for authentication, access control, intrusion detection and prevention and conduct research in Cyber Security 			
Unit	Topic	No. of lectures	
I	<p>Basic Networking Concepts: TCP/IP and OSI Model, Internet, working of Protocols at different layers.</p> <p>Introduction to CyberSecurity : Introduction to Cyber Security , Importance and challenges in Cyber Security , Cyberspace , Cyber threats , Cyber warfare , CIA Triad , Cyber Terrorism , Cyber Security of Critical Infrastructure , Cyber security , Organizational Implications</p>	12	

II	Hackers and Cyber Crimes Types of Hackers , Hackers and Crackers , Cyber-Attacks and Vulnerabilities , Malware threats , Reconnaissance, Sniffing , Gaining Access , Escalating Privileges , Executing Applications , Hiding Files , Covering Tracks , Worms , Trojans , Viruses , Backdoors	12
III	Ethical Hacking And Social Engineering Ethical Hacking Concepts and Scopes - Threats and Attack Vectors - Information Assurance - Threat Modeling - Enterprise Information Security Architecture - Vulnerability Assessment and Penetration Testing - Types of Social Engineering - Insider Attack - Preventing Insider Threats - Social Engineering Targets and Defense Strategies.	12
IV	Introduction to Cryptography: Network security model, Cryptographic systems, Cryptanalysis, Steganography. Types of Cryptography: Symmetric key and Asymmetric Key Cryptography, Encryption and Decryption Techniques. Cryptographic Algorithms: Cryptographic hash, Message Digest, Data Encryption Standard, Advanced Encryption Standard, RSA, ECC (Introductory concepts only)	12
V	Wireless Network Security Wireless Network Components, Security issues in Wireless Networks, Securing a Wireless Network Cyber Forensics And Auditing Introduction to Cyber Forensics - Computer Equipment and associated storage media - Role of forensics Investigator - Forensics Investigation Process - Collecting Network based Evidence - Writing Computer Forensics Reports - Auditing - Plan an audit against a set of audit criteria - Information Security Management System Management. Introduction to ISO 27001:2013.	12

Course Code	Course Title	Credits	Practical/ Tutorials Per Week
	Cyber Security	1	3
1	Perform Footprinting through Search Engines and social networking sites.		

2	Perform Host and Service discovery using NMAP
3	Identify the Target System's OS with Time-To-Live(TTL) and TCP Window Size using Wireshark
4	Perform Vulnerability research with vulnerability scoring systems and databases.
5	Write a Java program to perform encryption and decryption using the algorithms: a) Caesar Cipher b) Substitution Cipher c) Hill Cipher
6	Write a Java program to perform encryption and decryption using the algorithms: a) Playfair Cipher b) Vigenere Cipher
7	Write a Java program to implement the DES algorithm logic
8	Creating a Forensic Image using FTK Imager/Encase Imager : - Creating Forensic Image - Check Integrity of Data - Analyze Forensic Image
9	Create a new investigation case using Forensic Tool:(i) Computer System (ii) Computer Network (iii) Mobile Device (iv) Wireless Network.
10	Wireless Networking : a. Configure WEP Access point b. Bypass WEP encryption c. Bruteforcing WPA encryption

Course Code	Course Title	Credits	Lectures/Week
VESU SDS??	Natural Language Processing	3	5
<p>About the course To help learners learn data warehousing and mining architecture , understanding classification and prediction of data.</p>			
<p>Course Objectives The objectives of this course are:</p>			

- Students should be able to display data using appropriate visualization techniques (e.g., x-y line plots, bar charts, pie charts, scatter plots, histograms).
- Students should be able to understand and use basic statistical indicators (e.g., mean, median, standard deviation, maximum, minimum, tests of significance).
- Students should be able to apply built-in functions (e.g., sum, difference, log, exponential) appropriately and in context.
- Students should be able to use variables, conditionals, loops, functions, and logical indexing in scripts to analyze data.
- Students should be able to choose appropriate methods to solve problems.
- Students should be able to draw conclusions and formulate hypotheses from data presented graphically.
- Students should be able to write scripts that handle different types of data.
- Students should use models to generate data to study scientific questions.
- Students should be able to communicate their results in a clear and correct manner.

Learning Outcomes

After successful completion of this course -

- **Understand Natural Language Processing (Understanding).**
- **Probabilistic model of defining language and techniques.(Application)**
- **Applying the Hidden Markov model and Speech Recognition.(Application)**
- **Application of context free grammar and language parsing.(Application)**
- **Implement probabilistic and language parsing.(Application)**
- **Differentiation of semantic and discourse in terms of NLP(Analyze)**

Unit	Topic	No. of lectures
I	Introduction to NLP:Overview: Origins and challenges of NLP-Language and Grammar-Processing Indian Languages- NLP Applications-Information Retrieval. Knowledge in Speech and Language processing,ambiguity and models and algorithm,language and understanding,brief history, Language Modeling: Various Grammar- based Language Models-Statistical Language Model.	12

II	Regular Expressions, Automata, Similarity Computation: Regular Expressions, patterns, FA, Formal Language, NFSA, Regular Language and FSAs, Raw Text Extraction and Tokenization, Extracting Terms from Tokens, Vector Space Representation and Normalization, Similarity Computation in Text	12
III	Speech Sounds and Phonetic Transcription, The Phoneme and Phonological Rules, Phonological Rules and Transducers, Advanced Issues in Computational Phonology, Machine Learning of Phonological Rules, Mapping Text to Phones for TTS, Prosody in TTS	12
IV	N-grams: Counting Words in Corpora, Simple (Unsmoothed) N-grams, Smoothing, Backoff, Deleted, Interpolation, N-grams for Spelling and Pronunciation, Entropy. Probabilistic Models of Pronunciation and Spelling:	12
V	Probabilistic Models of Pronunciation and Spelling: Dealing with Spelling Errors, Spelling Error Patterns, Detecting Non Word Errors, Probabilistic Models, Applying the Bayesian method to spelling, Minimum Edit Distance, English Pronunciation Variation, The Bayesian method for pronunciation and Weighted Automata, Pronunciation in Humans.	12

Textbooks:

- Practical Natural Language Processing: A Comprehensive Guide to Building Real-World NLP Systems
- Packt Publications -Hands-On Natural Language Processing with Python, Sowmya Vajjala

Additional References:

1. Tanveer Siddiqui, U.S. Tiwary, "Natural Language Processing and Information Retrieval", Oxford University Press, 2008.
2. Anne Kao and Stephen R. Poteet (Eds), "Natural Language Processing and Text Mining", Springer-Verlag London Limited 2007.

Course Code	Course Title	Credits	Practical/ Tutorials Per
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			Week
VESUSD S??	Practical of Natural Language Processing	1	3
1	Finding the list of stop words for any Indian language like English and Hindi.		
2	Find out Word Analysis using Word Cloud in Python		
3	Get the dataset, tokenize the same and find out the chunks from the datasets		
4	Implement TF-IDF Vectorizer.		
5	Implement Stemming Lemmatization using Python		
6	Implement content based and collaboration based filtering using Python		
7	Implementing the application of N-gram model using Python		
8	Implementing semantic analysis using Python		
9	Execute sentiment analytics using Python		
10	Execute few of the practicals from above using a tool like Orange		

Course Code	Course Title	Credits	Lectures / Week
VESUSD S??	Big Data Technologies	3	5

About the course

This course would teach on the concepts of Big Data processing and the massive data. In addition to this, this course has introduced the tools like Hadoop-MapReduce and Spark etc

Course Objectives**The objectives of this course are:****OBJECTIVES :**

- 1.To understand the need of Big Data, challenges and different analytical architectures
- 2.Installation and understanding of Hadoop Architecture and its ecosystems
- 3.Processing of Big Data with Advanced architectures like Spark.
- 4.Describe graphs and streaming data in Spark

Learning Outcomes

After successful completion of this course -

- 1.Discuss the challenges and their solutions in Big Data
- 2.Understand and work on Hadoop Framework and eco systems.
3. Explain and Analyze the Big Data using Map-reduce programming in Both Hadoop and Spark framework.
4. Demonstrate spark programming with different programming languages.
- 5.Demonstrate the graph algorithms and live streaming data in Spark
6. Analyze and implement different frame work tools by taking sample data sets.
- 7.Project: illustrate and implement the concepts by taking an application problem.

Unit	Topic	No. of lectures
I	Big data- Concepts, Needs and Challenges of big data. Types and source of big data. Types of Digital Data, Introduction to Big Data, Big Data Analytics, Components of Hadoop Eco System- Data Access and storage, Data Intelligence, Data Integration, Data Serialization, Monitoring, Indexing.	
II	HDFS(Hadoop Distributed File System)- The Design of HDFS, HDFS Concepts, History of Hadoop, Apache Hadoop, Analyzing Data with Unix tools, Analyzing Data with Hadoop, Hadoop Streaming, Hadoop Ecosystem, IBM Big Data Strategy, Introduction to Infosphere BigInsights and Big Sheets. Command Line Interface, Hadoop file system interfaces, Data flow, Data Ingest with Flume and Sqoop and Hadoop archives, Hadoop I/O: Compression, Serialization, Avro and File-Based Data structures. Hadoop – Requirement of Hadoop Framework - Design principle of Hadoop –Comparison with other system - Hadoop Components – Hadoop 1 vs Hadoop 2 – Hadoop Daemon’s – HDFS Commands –	

	Map Reduce Programming: I/O formats, Map side join, Reduce Side Join, Secondary sorting, Pipelining MapReduce jobs	
III	MapReduce - Anatomy of a Map Reduce Job Run, Failures, Job Scheduling, Shuffle and Sort, Task Execution, Map Reduce Types and Formats, Map Reduce Features.	
IV	Hadoop EcoSystem - Pig : Introduction to PIG, Execution Modes of Pig, Comparison of Pig with Databases, Grunt, Pig Latin, User Defined Functions, Data Processing operators. Hive : Hive Shell, Hive Services, Hive Metastore, Comparison with Traditional Databases, HiveQL, Tables, Querying Data and User Defined Functions. Hbase : HBasics, Concepts,Serialization: AVRO, Coordination: Zookeeper, Databases: HBase, Hive, Scripting language: Pig, Streaming: Flink, Storm	
V	Data Analytics with R Machine Learning : Introduction, Supervised Learning, Unsupervised Learning, Collaborative Filtering. Big Data Analytics with BigR. Writing Spark Application - Spark Programming in Scala, Python, R, Java - Application Execution. Introduction to Data Lakes	

Text Books •

1. Tom White “ Hadoop: The Definitive Guide” Third Edit on, O’reily Media, 2012.
2. Seema Acharya, Subhasini Chellappan, "Big Data Analytics" Wiley 2015.
3. Anand Rajaraman and Jef rey David Ulman, “Mining of Massive Datasets”, Cambridge University Press, 2012.

References

- Michael Berthold, David J. Hand, "Intelligent Data Analysis”, Springer, 2007.
- Jay Liebowitz, “Big Data and Business Analytics” Auerbach Publications, CRC press (2013)
- Tom Plunkett, Mark Hornick, “Using R to Unlock the Value of Big Data: Big Data Analytics with Oracle R Enterprise and Oracle R Connector for Hadoop”, McGraw-Hill/Osborne Media (2013), Oracle press.
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- Bill Franks, “Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics”, John Wiley & sons, 2012.
- Glen J. Myat, “Making Sense of Data”, John Wiley & Sons, 2007
- Pete Warden, “Big Data Glossary”, O’Reily, 2011.

Course Code	Course Title	Credits	Practical/ Tutorials Per Week
		1	3
1	Execute HDFS Commands Map Reduce Program to show the need of Combiner Sequence file Input/Output Formats Secondary sorting		
2	Map Reduce I/O Formats-Text, key-value Map ReduceI/O Formats – Nline, Multiline		
3	Implement sequence file Input/Output Formats Secondary sorting		
4	Implementation of Distributed Cache & Map Side Join, Reduce side Join Building and Running a Spark Application		
5	Implement WordCount problem using Spark		
6	Execute MapReduce program to solve the wordcount problem		
7	Implement MapReduce program on any dataset to find out the Wordcount.		
8	Inverted Indexing in Spark Sequence alignment problem in Spark Implementation of Matrix algorithms in Spark Spark Sql programming,		
9	Implement building Spark Streaming application.		
10	Implement processing of large data situated on the cloud.		

Course Code	Course Title	Credits	Lect/ Week
	Principles of Management and Entrepreneurship	3	5

About the course

This course will give the idea of the basics of management principles and fundamentals of entrepreneurship. The course will give basic knowledge to the students of what is needed to start your own business.

Course Objectives**The objectives of this course are:**

- To help the students gain understanding of the functions and responsibilities of managers.
- To help the students to develop cognizance of the importance of management principles.
- To provide them tools and techniques to be used in the performance of the managerial job.
- To enable them to analyze and understand the principles of entrepreneurship and startups

Learning Outcomes

After successful completion of this course -

- Students will know the basic principles of management
- Students will know different types of businesses
- Students will know the various skills required to become a successful business person

Unit	Topic	No. of lectures
I	Definition of Management – Science or Art – Manager Vs Entrepreneur – types of managers -managerial roles and skills – Evolution of Management – Scientific, human relations, system and contingency approaches – Types of Business organization – Sole proprietorship, partnership, company-public and private sector enterprises – Organization culture and Environment – Current trends and issues in Management	12
II	Nature and purpose of planning – planning process – types of planning – objectives – setting objectives – policies – Planning premises – Strategic Management – Planning Tools and Techniques – Decision making steps and process.	12
III	Nature and purpose – Formal and informal organization – organization chart – organization structure – types – Line and staff authority – departmentalization – delegation of authority – centralization and decentralization – Job Design – Human Resource Management – HR Planning, Recruitment, selection, Training and Development, Performance Management, Career planning and management	12
IV	Introduction to Entrepreneurship Introduction, Concept of Entrepreneur, Entrepreneurship and Enterprise, Definition of Entrepreneurship, Objectives of Entrepreneurship Development, Phases of Entrepreneurship Development, Role of Entrepreneurship, The Entrepreneurial Mindset, Characteristics of Entrepreneurship, Traits of Entrepreneurship, Introduction to Entrepreneurship, Skills Entrepreneurship VS Startups	12
V	Meaning of Entrepreneurship skill, Types of Entrepreneurship Skills: Business management skills, Teamwork and leadership skills, Communication and listening, Customer service skills, Financial skills,	12

	Analytical and problem-solving skills, Critical thinking skills, Strategic thinking and planning skills, Technical skills, Time management and organizational skills, Branding, marketing and networking skills , How to improve entrepreneurial skills, Entrepreneurial skills in the workplace, Entrepreneurial Imagination And Creativity	
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TextBooks :

1. Principles of Management | 7th Edition Paperback – 14 November 2021 by PC Tripathi (Author), PN Reddy (Author), Ashish Bajpai (Author)
2. Entrepreneurship | 11th Edition Paperback – 6 August 2020 by Robert D. Hisrich (Author), Michael P. Peters (Author), Dean A. Shepherd (Author)
3. Zero to One: Notes on Start Ups, or How to Build the Future by Peter Thiel and Blake Masters

Additional References:

1. Fundamentals of Entrepreneurship (Book Code:1087) by Dr. G.K. Vashney | 1 January 2019
2. Surviving a Startup: Practical Strategies for Starting a Business, Overcoming Obstacles, and Coming Out on Top by Steven S. Hoffman | 20 April 2021
3. Principles of Management, Second Edition Paperback – 16 November 2019 by Ramesh B Rudani (Author)

Course Code	Course Title	Credits	Practical/ Tutorials Per Week
	Project	1	3

TYBSc

Semester VI

Course Code	Course Title	Credits	Lectures / Week
	Deep Learning	3	5
<p>About the course Deep learning can be an integral part of this course, in which this topic must have to be studied. After learning this topic students would be able to solve real world problems.</p>			
<p>Objectives</p> <ul style="list-style-type: none"> Introduce major deep learning algorithms, the problem settings, and their applications to solve real world problems. 			
<p>Learning Outcomes</p> <ul style="list-style-type: none"> Identify the deep learning algorithms which are more appropriate for various types of learning tasks in various domains. Implement deep learning algorithms and solve real-world problems. 			
Unit	Topic	No. of lectures	
I	Deep learning basics: Intro, History, capabilities, the perceptron Neural network learning: Back-Propagation Practical network training Autoencoders, Batch-normalization Why does it work? Overfitting and generalization		
II	Intro to CNNs, Convolution, Correlation, Filtering. CNN architectures o Detection and Segmentation Visualizing and Understanding Advanced CNNs for computer vision		

III	Recurrent Neural networks (RNNs) Advanced RNN: LSTM, GRU, Generative Adversarial Networks (GANs) Advanced GANs A guide to convolution arithmetic for deep learning, similarity of the deconvolution layer the same as a convolutional layer	
IV	Visualizing and Understanding Convolutional Networks, Deep Inside Convolutional Networks: Visualizing Image Classification Models and Saliency Maps, Understanding Neural Networks Through Deep Visualization, Learning Deep Features for Discriminative Localization	
V	Deep reinforcement learning Deep Learning: Good -> Great Visual Question Answering, Visual Dialog Novel deep methods (Deep internal learning, Deep image prior) Recent works How to stay updated? The study and understanding of Tensorflow and Pytorch	
<p>TextBooks :</p> <ol style="list-style-type: none"> 1. Deep Learning From Scratch: Building with Python from First Principles by Seth Weidman published by O`Reilley 2. Deep learning in Python/ Pytorch by Manning Publications 3. Francois Chollet Deep Learning with Python. <p>Additional References:</p> <p>Stevens Antega, Deep Learning with PyTorch</p>		

Course Code	Course Title	Credits	Practical/ Tutorials Per Week
	Practical of Deep Learning and Neural Networks	1	3
1	Implementation of Computer Vision		
2	Implementation of Natural Language Processing (NLP)		
3	Implementation of Sequence modeling		
4	Implementation of Natural / Biological signals		

5	Implementation of various problem statements using Tensorflow
6	Implementation of various problem statements using Pytorch
7	Implement Movie dataset analysis by taking the different datasets
8	Implement the recommendation system

Course Code	Course Title	Credits	Lect/Week
	Business Intelligence & Web Analytics	3	5
<p>About the course This course is designed to introduce students to business intelligence concepts and provide students with an understanding of web analytics and web intelligence.</p>			
<p>Course Objectives The objectives of this course are:</p> <ul style="list-style-type: none"> ● To give idea of business intelligence ● To cover the concepts of web analytics and how it can be useful to business ● To know various metrics and tools used ● To throw light on analytics done by google and other social media platforms 			
<p>Learning Outcomes After successful completion of this course -</p> <ul style="list-style-type: none"> ● Students will have a solid understanding of business intelligence and web analytics ● Students will know how Analysts impact the various businesses ● Students will get an idea of various analytics tools ● Students will know how to deploy web intelligence to improve the outcomes of your marketing or business plan. 			
Unit	Topic	No. of lectures	
I	Origins of Business Intelligence (BI), Main characteristics of BI, Structure and components of BI, Business Intelligence now and in the future Measuring, Monitoring and management of Business, KPIs and dashboard, the types of dashboards, the common characteristics of	12	

	Enterprise dashboard, design of enterprise dashboards, and the common pitfalls of dashboard design.	
II	Web Analytics: Purpose, History, Goals & objectives, Web Analytic tools & Methods. Web Analytics Mistakes and Pitfalls. Web Analytic fundamentals: Capturing data: Web logs or JavaScripts tags, Separate data serving and data capture, Type and size of data, Innovation, Integration, Selecting optimal web analytic tool, Understanding clickstream data quality, Identifying unique page definition, Using cookies, Link coding issues.	12
III	Web Metrics: Common metrics: Hits, Page views, Visits, Unique visitors, Unique page views, Bounce, Bounce rate, Page/visit, Average time on site, New visits; Optimization(e-commerce, non e-commerce sites): Improving bounce rates, Optimizing adwords campaigns; Real time report, Audience report, Traffic source report, Custom campaigns, Content report, Google analytics, Introduction to KPI, characteristics, Need for KPI, Perspective of KPI, Uses of KPI.	12
IV	Google Analytics: Basics of Google Analytics, Installing Google Analytics in website, Parameters of Google Analytics, Reporting and Analysis Social Media Analytics - Analytics related to social media like Facebook, LinkedIn, Youtube, Twitter,	12
V	Web Intelligence: Semantic web, Social intelligence, Search engine techniques, Web information retrieval and filtering, Levels of WI, Goal of WI, Characteristics of web intelligence, Challenges and issues of WI, Future of WI. Web mining: Evolution, Process, Web content mining, Web usage mining, Web structure mining.	12

TextBooks :

1. Business Intelligence, Analytics, and Data Science: A Managerial Perspective | Fourth Edition | By Pearson by Ramesh Sharda / Dursun Delen / Efraim Turban | 25 March 2019
2. Web Analytics For Dummies by Pedro Sostre and Jennifer LeClaire | 1 February 2022
3. Social Media Analytics: Techniques and Insights for Extracting Business Value Out of Social Media by Matthew Ganis and Avinash Kohirkar | 11 December 2015
4. Successful Business Intelligence, Second Edition: Unlock the Value of BI and Big Data by Cindi Howson

Additional References:

1. Clifton B., Advanced Web Metrics with Google Analytics, Wiley Publishing, Inc. (2010), 2nd ed

2. Marshall Sponder Social Media Analytics

Course Code	Course Title	Credits	Practical/ Tutorials Per Week
	Business Intelligence & Web Analytics	1	3
1	Practical on BI tools- I		
2	Practical on BI tools- II		
3	Practical on Web Analytics Tool - I		
4	Practical on Web Analytics Tool - II		
5	Practicals on Google Analytics		
6	Practical on Social Media Analytics Tools - I		
7	Practical on Social Media Analytics Tools - II		
8	Practical on BI tool		

Course Code	Course Title	Credits	Lect/ Week
	Bioinformatics	3	5

About the course

This is an introductory course to explore various other areas in which requires data analysis of a different type. This course would give idea of data science and data analysis can be used in biological domain.

Course Objectives**The objectives of this course are:**

- Develop basic knowledge on the available online biological databases.
- Experiment with of all kinds of nucleotide and protein databases and the best use of it throughout their course.
- Discover the area of interest from the available database information

Learning Outcomes

After successful completion of this course -

- Analyze nucleotide and protein sequence from various databases.
- Build an extensive knowledge of model organisms and to browse genome databases to retrieve useful information's which will be helpful for their research work.
- Distinguish the intersection of life and information sciences, information theory, gene expression, and database queries
- Apply existing software effectively to extract information from large databases and to use this information in computer modeling.
- Demonstrate critical thinking and research methods in Bioinformatics to understand computational and experimental data.
- Evaluate sequence, structural, and functional analysis of biomolecules.

Unit	Topic	No. of lectures
I	Types of macro molecules, metabolites and products. Properties of water. Cellular carbohydrates, lipids and their classification Classification and properties of amino acids. Peptides and structure of proteins, Ramachandran Plot DNA and RNAs. Nucleoside and nucleotides. Structure, function and properties of nucleic acids. Human Genome Project	12
II	Motivation of biological database - Central dogma of life - Submission of sequences to the database, sequence formats, conversion of one sequence into another ENSEMBL Human - UCSC Human Genome Browser Gateway and other vertebrate genome databases. DNA microarray: database and basic tools, Gene Expression Omnibus (GEO) and SAGE databases. BioGRID: Database of Protein, Chemical, and Genetic Interactions, STRING : functional protein association networks, DIP - Database of Interacting Proteins	12

<p>III</p>	<p>Scope and applications of bioinformatics, Alignment of pairs of sequences; Introduction- Definition of sequence alignment, Methods - Dot matrix sequence comparison</p> <p>Sequence Alignment - Dynamic programming algorithm for sequence alignment – Global Alignment: Needleman- Wunsch, Local Alignment: Smith-Waterman , Gap penalty, Assessing the significance of an alignment</p> <p>Dynamic programming, progressive methods, Iterative methods, MSA using CLUSTAL W, PILEUP and CLUSTAL X, purpose and applications of multiple sequence alignment</p>	<p>12</p>
<p>IV</p>	<p>Scoring Matrices - Similarity searches - PAM and BIOSUM matrix, Dayhoff mutation matrix, construction of PAM and BLOSUM matrix. Differences between PAM & BLOSUM</p> <p>Database Search Methods - Database searching for similar sequences. Sequence similarity search, FASTA sequence database similarity search, BLAST sequence database similarity search, other methods of comparing database of sequences and patterns.</p> <p>Develop basic scripts and pipelines for automating and repeating analyses</p>	<p>12</p>
<p>V</p>	<p>Modeling, Visualization and Dynamics</p> <p>USing RasMOL, PyMOL, AutoDock 4.2, Gromacs, CHARMM</p>	<p>12</p>

TextBooks :

1. Attwood TK and Parry-Smith DJ (2014) Introduction to bioinformatics, Pearson Education.
2. Baxevanis A., Ouellette F.B.F. (Eds.) Bioinformatics: a practical guide to the analysis of genes and proteins. John Wiley and Sons, New York (1998).

Additional References:

1. Bioinformatics: Sequence and Genome Analysis David W.Mount, David Mount
2. Bioinformatics: the Machine Learning Approach – Pierre Baldi and Søren Brunak Publisher: MIT Press.
3. Mount D (2014) Bioinformatics: Sequence and Genome Analysis, Cold Spring Harbor

Course Code	Course Title	Credits	Practical/ Tutorials Per Week
	Practicals of Bioinformatics	1	3
1	Study of basic elements like proteins, amino acids, DNA, RNA etc		
2	NCBI, EMBL, DDBJ, CATH, SCOP Data submission and retrieval		
3	BLAST tool		
4	CLUSTAL Omega		
5	Galaxy Web Server 1		
6	Galaxy Web Server 2		
7	SwissModel		
8	RasMol and PyMol		

Course Code	Course Title	Credits	Lectures / Week
	BlockChain	3	5
<p>About the course This course is intended to study the basics of Blockchain technology. During this course the learner will explore various aspects of Blockchain technology like application in various domains. By implementing, learners will have ideas about private and public Blockchain, and smart contracts.</p>			
<p>Course Objectives The objectives of this course are:</p>			

- Students will be able to Understand how blockchain systems (mainly Bitcoin and Ethereum) work,
- To securely interact with them,
- Design, build, and deploy smart contracts and distributed applications,
- Integrate ideas from blockchain technology into their own projects.

Learning Outcomes

After successful completion of this course -

- Student will be able to Understand and explore the working of Blockchain technology (Understanding)
- Analyze the working of Smart Contracts (Analyze)
- Understand and analyze the working of Hyperledger (Analyze).
- Apply the learning of solidity and decentralized apps on Ethereum (Apply).

Unit	Topic	No. of lectures
I	Distributed Database, Two General Problem, Byzantine General problem and Fault Tolerance, Hadoop Distributed File System, Distributed Hash Table, ASIC resistance, Turing Complete. • Cryptography: Hash function, Digital Signature - ECDSA, Memory Hard Algorithm, Introduction of Cryptography and Blockchain: What is Blockchain, Blockchain Technology Mechanisms & Networks, Blockchain Origins	12
II	Objective of Blockchain: Blockchain Challenges, Transactions And Blocks, P2P Systems, Keys As Identity, Digital Signatures, Hashing, and public key cryptosystems, private vs. public Blockchain. Advantage over conventional distributed databases, Distributed Consensus, Merkle Patricia Tree, Gas Limit, Transactions and Fee, Anonymity, Reward, Chain Policy, Life of Blockchain application, Soft & Hard Fork. Applications: Internet of Things, Medical Record Management System, Domain Name Service and future of Blockchain.	12
III	BitCoin and Cryptocurrency: What is Bitcoin, The Bitcoin Network, The Bitcoin Mining Process, Mining Developments, Bitcoin Wallets, Decentralization and Hard Forks, Ethereum Virtual Machine (EVM), Merkle Tree, Double-Spend Problem, Blockchain And Digital Currency,	12

	<p>Transactional Blocks, Impact Of Blockchain Technology On Cryptocurrency.</p> <p>Distributed Ledger, Bitcoin protocols - Mining strategy and rewards, Ethereum - Construction, DAO, Smart Contract, GHOST, Vulnerability, Attacks, Sidechain, Namecoin</p>	
IV	<p>Introduction to Ethereum: What is Ethereum, Introduction to Ethereum, Consensus Mechanisms, How Smart Contracts Work, Metamask Setup, Ethereum Accounts, Receiving Ether's What's a Transaction?, Smart Contracts.</p> <p>Introduction to Hyperledger: What is Hyperledger? Distributed Ledger Technology & its Challenges, Hyperledger & Distributed Ledger Technology, Hyperledger Fabric, Hyperledger Composer.</p>	12
V	<p>Solidity Programming: Solidity - Language of Smart Contracts, Installing Solidity & Ethereum Wallet, Basics of Solidity, Layout of a Solidity Source File & Structure of Smart Contracts, General Value Types (Int, Real, String, Bytes, Arrays, Mapping, Enum, address)</p> <p>Blockchain Applications: Internet of Things, Medical Record Management System, Domain Name Service and Future of Blockchain, Alt Coins.</p>	12
<p>TextBooks :</p> <ol style="list-style-type: none"> 1. Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller and Steven Goldfeder, Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction, Princeton University Press (July 19, 2016). <p>Additional References:</p> <ol style="list-style-type: none"> 1. Antonopoulos, Mastering Bitcoin. 2. D. Drescher, Blockchain Basics. Apress, 2017 3. Satoshi Nakamoto, Bitcoin: A Peer-to-Peer Electronic Cash System 4. DR. Gavin Wood, "ETHEREUM: A Secure Decentralized Transaction Ledger,"Yellow paper.2014. 		

Course Code	Course Title	Credits	Practical/ Tutorials Per Week
	Practical of BlockChain	1	3

1	Create a Simple Blockchain in any suitable programming language.
2	Use Geth to Implement Private Ethereum BlockChain.
3	Build Hyperledger Fabric Client Application
4	Build Hyperledger Fabric with Smart Contract.
5	Create Case study of BlockChain being used in illegal activities in the real world.
6	Using Python Libraries to develop BlockChain Application.
7	creating wallets and sending cryptocurrency
8	Tokenization and trading cryptocurrencies Play with Go-ethereum
9	Smart Contract Construction, Toy application using Blockchain
10	Mining puzzles

Course Code	Course Title	Credits	Lectures / Week
	Green Computing	3	4

About the course

To help learners learn green computing and green technologies for making computing and environments sustainable.

Course Objectives

The objectives of this course are:

- To familiarize with the concept of Green Computing and Green IT infrastructure for making computing and information system environments sustainable.
- Encouraging optimized software and hardware designs for development of Green IT

Storage, Communication and Services.

- To highlight useful approaches to embrace green IT initiatives.

Learning Outcomes

After successful completion of this course -

- Learning about green IT can be achieved in and by hardware, software, network communication and data center operations.
- Understand the strategies, frameworks, processes and management of green IT

Unit	Topic	No. of lectures
I	<p>Overview and Issues: Problems: Toxins, Power Consumption, Equipment Disposal, Company’s Carbon Footprint: Measuring, Details, reasons to bother, Plan for the Future, Cost Savings: Hardware, Power.</p> <p>Initiatives and Standards: Global Initiatives: United Nations, Basel Action Network, Basel Convention, North America: The United States, Canada, Australia, Europe, WEEE Directive, RoHS, National Adoption, Asia: Japan, China, Korea.</p> <p>Green Devices and Hardware: Introduction , Life Cycle of a Device or Hardware, Reuse, Recycle and Dispose</p> <p>Green Software: Introduction , Processor Power States , Energy-Saving Software Techniques, Evaluating and Measuring Software Impact to Platform Power</p>	
II	<p>Minimizing Power Usage: Power Problems, Monitoring Power Usage, Servers, Low-Cost Options, Reducing Power Use, Data Deduplication, Virtualization, Management, Bigger Drives, Involving the Utility Company, LowPower Computers, PCs, Linux, Components, Servers, Computer Settings, Storage, Monitors, Power Supplies, Wireless Devices, Software.</p> <p>Green Data Storage: Introduction , Storage Media Power Characteristics, Energy Management Techniques for Hard Disks, System-Level Energy Management Green Networks and Communications: Introduction, Objectives of Green Network Protocols, Green Network Protocols and Standards</p>	
III	<p>Changing the Way of Work: Old Behaviors, starting at the Top, Process Reengineering with Green in Mind, Analyzing the Global Impact of Local Actions, Steps: Water, Recycling, Energy, Pollutants,</p>	

	<p>Teleworkers and Outsourcing, Telecommuting, Outsourcing, how to Outsource.</p> <p>Going Paperless: Paper Problems, The Environment, Costs: Paper and Office, Practicality, Storage, Destruction, Going Paperless, Organizational Realities, Changing Over, Paperless Billing, Handheld Computers vs. the Clipboard, Unified Communications, Intranets, What to Include, Building an Intranet, Microsoft Office SharePoint Server 2007, Electronic Data Interchange (EDI), Nuts and Bolts, Value Added Networks, Advantages, Obstacles.</p>	
IV	<p>Sustainable Information Systems and Green Metrics: Introduction, Multilevel Sustainable Information, Sustainability Hierarchy Models, Product Level Information, Individual Level Information, Functional Level Information, Organizational Level Information, Measuring the Maturity of Sustainable ICT</p> <p>Enterprise Green IT Readiness: Introduction, Readiness and Capability, Development of the G-Readiness Framework, Measuring an Organization's G-Readiness</p> <p>Sustainable IT Services: Creating a Framework for Service Innovation: Introduction, Factors Driving the Development of Sustainable IT, Sustainable IT Services (SITS), SITS Strategic Framework Green</p> <p>Enterprises and the Role of IT: Introduction, Organizational and Enterprise Greening, Information Systems in Greening Enterprises, Greening the Enterprise: IT Usage and Hardware, Inter-organizational Enterprise Activities and Green Issues</p>	
V	<p>Recycling: Problems, China, Africa, Materials, Means of Disposal, Recycling, Refurbishing, Make the Decision, Life Cycle, from beginning to end, Life, Cost, Green Design, Recycling Companies, Finding the Best One, Checklist, Certifications, Hard Drive Recycling, Consequences, cleaning a Hard Drive, Pros and cons of each method, CDs and DVDs, good and bad about CD and DVDs disposal, Change the mind-set, David vs. America Online</p> <p>Staying Green: Organizational Check-ups, Chief Green Officer, Evolution, Sell the CEO, SMART Goals, Equipment Check-ups, Gather Data, Tracking the data, Baseline Data, Benchmarking, Analyze Data, Conduct Audits, Certifications, Benefits, Realities, Helpful Organizations.</p>	
TextBooks :		

1. Harnessing Green IT: Principles and Practices, San Murugesan, G. R. Ganadharan, Wiley & IEEE.
2. Green Data Center: Steps for the Journey, Alvin Galea, Michael Schaefer, Mike Ebbers, Shroff Publishers and Distributors, 2011
3. Green Computing and Green IT Best Practice, Jason Harris, Emereo, 2014
4. Green Computing Tools and Techniques for Saving Energy, Money and Resources, Bud E. Smith, CRC Press, 2014

Additional References:

1. Green IT, Deepak Shikarpur, Vishwakarma Publications, 2014
2. Green Communications: Principles, Concepts and Practice- Samdanis et al, J. Wiley
3. Green IT for Sustainable Business Practice: An ISEB Foundation Guide, Mark G. O'Neill, The Chartered Institute for IT, 2010

Course Code	Course Title	Credits	Practical/ Tutorials Per Week
	Project	1	3