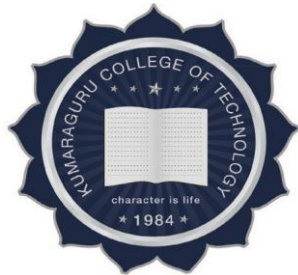# KUMARAGURU COLLEGE OF TECHNOLOGY

(Autonomous Institution Affiliated to Anna University, Chennai)

COIMBATORE – 641049

CURRICULUM & SYLLABUS
CHOICE BASED CREDIT SYSTEM
(REGULATIONS 2020)

I to IV Semester

MCA

Department of Computer Applications

MASTER OF COMPUTER APPLICATIONS (2 YEARS)

VISION

The Department,

- Seeks to create academic programs and a campus culture that imbibes a socially committed professionalism which would in turn feed into the overall development of the society and make global citizens and leaders out of the students.
- Aims to become a highly recognized, research driven department with good infrastructure, developing industry ready products.

MISSION

- The Department is committed to set standards of excellence in its academic programmes by enabling its students to achieve a blending of knowledge acquisition and applications of such knowledge in real life situations.
- It is also aimed to equip them to adapt themselves to changing global and local needs upholding professional ethics and contribute their might in transforming India into a world leader in technological advancement and prosperity.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

PEOs for MCA programme are designed based on the department mission.

- To prepare students to transact in the field of computer applications by providing technical foundations in the field of computer applications.
- To prepare students to intellect in computing skills and innovation of software products to meet the industry needs.
- To provide exposure to cutting edge technologies and training to work on multidisciplinary. projects in a team.
- To prepare students to life-long learning through professional activities; adapt themselves with ease to new technologies, while exhibiting ethical and professional standards.

PROGRAM OUTCOMES (PO'S):

On successful completion of the program:

1. **Computational Knowledge**: Apply knowledge of computing fundamentals, computing specialization, mathematics, and domain knowledge appropriate for the computing specialization to the abstraction and conceptualization of computing models from defined problems and requirements.

2. **Problem Analysis:** Identify, formulate, research literature, and solve complex computing problems reaching substantiated conclusions using fundamental principles of mathematics, computing sciences, and relevant domain disciplines.

3. **Design /Development of Solutions:** Design and evaluate solutions for complex computing problems, and design and evaluate systems, components, or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.

4. **Conduct Investigations of Complex Computing Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. **Modern Tool Usage:** Create, select, adapt and apply appropriate techniques, resources, and modern computing tools to complex computing activities, with an understanding of the limitations.

6. **Professional Ethics:** Understand and commit to professional ethics and cyber regulations, responsibilities, and norms of professional computing practice.

7. **Life-long Learning:** Recognize the need, and have the ability, to engage in independent learning for continual development as a computing professional.

8. **Project management and finance:** Demonstrate knowledge and understanding of the computing and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

9. **Communication Efficacy:** Communicate effectively with the computing community, and with society at large, about complex computing activities by being able to comprehend and write effective reports, design documentation, make effective presentations, and give and understand clear instructions.

10. **Societal and Environmental Concern:** Understand and assess societal, environmental, health, safety, legal, and cultural issues within local and global contexts, and the consequential responsibilities relevant to professional computing practice.

11. **Individual and Team Work:** Function effectively as an individual and as a member or leader in diverse teams and in multidisciplinary environments.

12. **Innovation and Entrepreneurship:** Identify a timely opportunity and using innovation to pursue that opportunity to create value and wealth for the betterment of the individual and society at large.

REGULATION 2020

MCA CURRICULUM

SEMESTER I							
Course Code	**Course Title**	**Course Mode**	**L**	**T**	**P**	**J**	**C**
P20CAT1001	Data Structures and Algorithms	Theory	3	0	0	0	3
P20CAT1002	Database Technologies	Theory	3	0	0	0	3
P20CAT1103	Advanced Operating Systems	Theory	3	1	0	0	4
P20CAT1004	Programming with JAVA	Theory	3	0	0	0	3
P20MAT1101	Probability and Statistics for Data Analysis	Theory	3	1	0	0	4
P20CAP1501	Database Technologies Laboratory	Lab	0	0	4	0	2
P20CAP1502	Data Structures Lab using C	Lab	0	0	4	0	2
P20CAP1503	Programming with Java Lab	Lab	0	0	4	0	2
						Total Credits	**23**
						Total Hours Per Week	**29**

SEMESTER II							
Course Code	**Course Title**	**Course Mode**	**L**	**T**	**P**	**J**	**C**
P20CAT2001	Software Engineering Methodologies and Quality Assurance	Theory	3	0	0	0	3
P20CAI2202	Web Technologies	Embedded Theory & Lab	3	0	2	0	4
P20CAT2003	Data Intensive Computing	Theory	3	0	0	0	3
P20CAT2004	Data Communications and Networks	Theory	3	0	0	0	3
E-I	Elective I	Theory	3	0	0	0	3
E-II	Elective II	Theory	3	0	0	0	3
P20CAP2501	Data Intensive Computing Lab using Python	Lab	0	0	4	0	2
P20CAP2702	Mini Project	Project	0	0	0	4	2
P20CAI2603	Engineering Clinics	**Lab & Project**	0	0	2	2	2

	Total Credits	25
	Total Hours Per Week	32

SEMESTER III							
Course Code	Course Title	Course Mode	L	T	P	J	C
P20CAI3201	Service Oriented Architecture	Embedded Theory & lab	3	0	2	0	4
P20CAT3002	Ethics in computing	Theory	3	0	0	0	3
P20CAI3203	Cloud Application Development	Embedded Theory & lab	3	0	2	0	4
P20CAT3004	Artificial Intelligence	Theory	3	0	0	0	3
E-III	Elective III	Theory	3	0	0	0	3
E-IV	Elective IV	Theory	3	0	0	0	3
E -V	Elective V	Theory	3	0	0	0	3
P20CAP3501	Mobile Computing Lab	Lab	0	0	4	0	2
					Total Credits		25
					Total Hours Per Week		29

SEMESTER IV							
Course Code	Course Title	Course Mode	L	T	P	J	C
P20CAP4701	Project Work / Industry	Project	0	0	0	24	12
					Total Credits		12
					Total Hours per week		24

Total Credits: 85

Professional Electives – Specialization track (From 2023 Batch)

S. No.	Specialization Track	Course Code	Course Name	L	T	P	J	Credit
1.	Extended Reality	P20CAE0321	3D Modeling and Game Design	2	0	0	2	3
2.		P20CAE0322	Augmented Reality and Virtual Reality Application Development	2	0	0	2	3
3.		P20CAE0023	Advanced Metaverse Technologies	3	0	0	0	3
4.	IoT, Edge, UAV	P20CAE0224	Embedded Systems for IoT	2	0	2	0	3
5.		P20CAE0325	IoT Systems Design	2	0	0	2	3
6.		P20CAE0226	IoT Application Development	2	0	2	0	3
7.		P20CAE0227	3D Printing	2	0	2	0	3
8.		P20CAE0228	Robotic Operating Systems	2	0	2	0	3
9.		P20CAE0029	Software Defined Vehicle	3	0	0	0	3
10.	Cyber Security	P20CAE0230	Ethical Hacking and Network Defence	2	0	2	0	3
11.		P20CAE0031	Cyber Ethics and Laws	3	0	0	0	3
12.		P20CAE0232	Secure Software Development	2	0	2	0	3
13.		P20CAE0233	Network Security Administration	2	0	2	0	3
14.	Automation and Artificial Intelligence	P20CAE0235	Computer Vision	2	0	2	0	3
15.		P20CAE0236	Natural Language Processing	2	0	2	0	3
16.		P20CAE0237	Generative AI	2	0	2	0	3
17.		P20CAE0038	Responsible AI	3	0	0	0	3
18.	Data Science, Analytics and Visualization	P20CAE0239	Principles of Data Science	2	0	2	0	3
19.		P20CAE0240	Data Processing Techniques	2	0	2	0	3
20.		P20CAE0241	Data Modelling	2	0	2	0	3
21.		P20CAE0242	Data Analysis and Visualization	2	0	2	0	3
22.		P20CAE0243	Business Intelligence for Decision Making	2	0	2	0	3
23.		P20CAE0044	Data Ethics and Privacy	3	0	0	0	3
24.	Network and Distributed Computing	P20CAE0245	Smart Contract Development	2	0	2	0	3
25.		P20CAE0046	Decentralized Finance	3	0	0	0	3
26.	Cloud Computing	P20CAE0247	Virtualization and Resource Management	2	0	2	0	3
27.		P20CAE0248	Cloud Infrastructure and Architecture	2	0	2	0	3
28.		P20CAE0249	Cloud Storage Management	2	0	2	0	3
29.		P20CAE0250	Cloud Security	2	0	2	0	3

S. No	Course Code	Course Title	L	T	P	J	C
30.		P20CAE0351	Cloud Automation	2	0	0	2	3
31.	Web and Software Development	P20CAE0252	Full Stack Software Development	2	0	2	0	3

OTHER ELECTIVES

S. No	Course Code	Course Title	Course Mode	L	T	P	J	C
1.	P20CAE0001	Information Security	Theory	3	0	0	0	3
2.	P20CAE0002	Object Oriented Analysis and Design	Theory	3	0	0	0	3
3.	P20CAE0003	Game Development	Theory	3	0	0	0	3
4.	P20CAE0004	Software Project Management	Theory	3	0	0	0	3
5.	P20CAE0005	E-Commerce	Theory	3	0	0	0	3
6.	P20CAE0006	TCP/IPV6 Protocol Suite	Theory	3	0	0	0	3
7.	P20CAE0007	Wireless Networks	Theory	3	0	0	0	3
8.	P20CAE0008	Blockchain Technologies	Theory	3	0	0	0	3
9.	P20CAE0009	Accounting and Financial Management	Theory	3	0	0	0	3
10.	P20CAE0010	Enterprise Resource Planning	Theory	3	0	0	0	3
11.	P20CAE0011	Business Domains in Computer Applications	Theory	3	0	0	0	3
12.	P20CAE0012	Big Data Analytics	Theory	3	0	0	0	3
13.	P20CAE0013	Mixed Reality	Theory	3	0	0	0	3
14.	P20CAE0014	Deep Learning Techniques and Applications	Theory	3	0	0	0	3
15.	P20CAE0015	E-Learning Techniques	Theory	3	0	0	0	3
16.	P20CAE0016	Ethical Hacking	Theory	3	0	0	0	3
17.	P20CAE0017	Middleware Technologies	Theory	3	0	0	0	3
18.	P20CAE0018	Robotic Process Automation	Theory	3	0	0	0	3
19.	P20CAE0019	Linux Administration	Theory	3	0	0	0	3
20	P20CAE0020	User Interface Design and User Experience	Theory	3	0	0	0	3

ONE CREDIT COURSES

S.NO	COURSE CODE	COURSE TITLE
1.	P20CAC0201	Agile Methodology
2.	P20CAC0202	Introduction to Ethical Hacking
3.	P20CAC0203	Soft Skills
4.	P20CAC0204	Technical Writing
5.	P20CAC0205	Human Excellence – Professional Values
6.	P20CAC0206	Data Analytics

KUMARAGURUCOLLEGE OF TECHNOLOGY,
COIMBATORE – 641 049
Department of Computer Applications

Regulations 2020

MCA SYLLABUS

SEMESTER – I

P20CAT1001	DATA STRUCTURES AND ALGORITHMS	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Analyze the performance of algorithms.
CO2: Apply the knowledge of basic data structures and their implementations.
CO3: Develop skills in applying linear and nonlinear data structures.
CO4: Apply different algorithmic design strategies.
CO5: Understand the concepts of P and NP classes

Pre–requisite: Nil

Cos	PROGRAMME OUTCOMES (POs) (S/M/W Indicates Strength of Correlation) S-Strong, M-Medium, W- Weak											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	M	M				M					
CO2	M	W	M				M					
CO3			W	S				M				
CO4	M		M									
CO5	W	W										

COURSE ASSESSMENT METHODS

DIRECT

1. Continuous Assessment Test I, II
2. Assignment
3. Demonstration etc (as applicable)
4. End Semester Examination

INDIRECT

1.Course-end survey

ALGORITHM ANALYSIS	7 Hours

Fundamentals of Algorithm Problem Solving- Fundamentals of Analysis of Algorithm – Efficiency – Analysis Framework - Asymptotic Notations – Mathematical Analysis of Recursive and Non–recursive Algorithms– Analysis of Algorithms – Time complexities.

ARRAYS AND LINKED LIST	9 Hours

Arrays- Representation – Operations on Arrays – Linked List- Basic Concepts and Operations-Types of Linked List : Doubly Linked List – Singly Linked List – Stack :Definition – Operations on Stack – Static and Dynamic Implementation of a Stack – Recursion using Stack - Definition – Operations on Queue – Static and Dynamic Implementation of a Queue.

GRAPHS	10 Hours
Introduction –Terminology - Representation of Graph - Graph Traversals: Depth-first and Breadth-first Traversal - Applications of Graphs – Transitive Closure: Warshall's Algorithm -Shortest-path Algorithms: Dijkstra's Algorithm – Floyd's Algorithm - Minimum Spanning Tree – Prim's and Kruskal's Algorithms.	

TREES	6 Hours
Trees – Introduction - Binary Search Tree (BST) :Introduction -Operations– B – Trees :Definition, Operations.	

DESIGN STRATEGIES	9 Hours
Divide and Conquer - Introduction – Quick Sort- Merge Sort -Binary Search – Analysis- Backtracking: Introduction - n–Queens Problem – Hamiltonian Circuit Problem – Branch and Bound: Introduction – Assignment Problem – Knapsack Problem.	

COMPUTABILITY	4 Hours
P, NP, NP-complete and NP-hard.	

Theory: 45 Hours	Tutorial: -	Total : 45 Hours

REFERENCES:

1. Anany Levitin, "Introduction to the Design and Analysis of Algorithms", Third Edition, Pearson Education, 2017.
2. Mark Allen Weiss, "Data Structures and Algorithm Analysis in C", Pearson Education,2006.
3. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein "Introduction to Algorithms", The MIT Press, Third edition, 2009.
4. VijayalakshmiPai G.A, "Data Structures and Algorithms: Concepts Techniques and Applications", McGraw Hill, 2009.
5. Horowitz Ellis and SartajSahni, "Fundamentals of Computer Algorithms", Galgotia Publications, 2004.

P20CAT1002	DATABASE TECHNOLOGIES	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Use the techniques, components and tools of atypical database management system.

CO2: Understand basic database concepts, including the structure and operation of the relational data model.

CO3: Demonstrate the different types of database implementation concepts.

CO4: Understand the emerging database technologies.

CO5: Familiarize with NoSQL concepts.

Pre–requisite :Nil

Cos	PROGRAMME OUTCOMES (POs) (S/M/W Indicates Strength of Correlation) S-Strong, M-Medium, W- Weak											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	S			M							
CO2	M											
CO3	S		M		M							
CO4	M						M					
CO5	M	M										

COURSE ASSESSMENT METHODS

DIRECT

1. Continuous Assessment Test I, II
2. Assignment
3. Demonstration etc (as applicable)
4. End Semester Examination

INDIRECT

1. Course-end survey

INTRODUCTION	9 Hours

Introduction – Database Architecture – Structure of Relational Databases – Database Schema – Schema Diagrams – Relational Query Languages – Keys – Basic Structure of Queries and SQL Operations – Integrity Constraints – ER Model.

DATABASE DESIGN	9 Hours

Relational Database Design – First Normal Form – Second Normal Form – Third Normal Form Boyce - Codd Normal Form – Case Study: Normalization Process – Front end and Back end – MySQL – Connectivity using ODBC/JDBC.

DATABASE IMPLEMENTATION	9 Hours

Physical Database Design and Tuning – Database Transaction: Transaction Concept and State – Concurrency Control: Two-Phase locking protocol – Recovery: Failure Classification – LogBased Recovery – Shadow Paging.

EMERGING TECHNOLOGIES AND APPLICATIONS	**9 Hours**
Active Database Concepts and Triggers – Distributed Databases: Concepts – Database Design and Types – Database Applications in Mobile Communication – Multimedia Databases – Genome Data Management.	
NoSQL	**9 Hours**
Introduction – Aggregate Data Model – Distribution Model – NoSQL Implementation: Key Value Database – Document Database – MongoDB.	

Theory: 45 Hours	**Tutorial: -**	**Total : 45 Hours**

REFERENCES :

1. Abraham Silberschatz, Henry F.Korth and S.Sudarshan, "Database System Concepts", 7th Edition, Tata McGraw Hill International Edition, 2019.
2. Pramodkumar J. Sadalage and Martin Fowler, "NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence", 1st Edition, Addison Wesley Professional, 2012.
3. R. Elmasri and S.B. Navathe, "Fundamentals of Database Systems", 6th Edition, Pearson Education, 2011.

P20CAT1103	ADVANCED OPERATING SYSTEMS	L	T	P	J	C
		3	1	0	0	4

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Know the basic concepts of operating systems.

CO2: Understand process management, synchronization and deadlock concepts.

CO3: Analyze various memory management techniques and disk scheduling algorithms.

CO4: Demonstrate file system, Allocation Methods and Free space management.

CO5: Understand Virtualization.

CO6: Compare various mobile operating System

Pre–requisite: Nil

Cos	PROGRAMME OUTCOMES (POs) (S/M/W Indicates Strength of Correlation) S-Strong, M-Medium, W- Weak											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S											
CO2		S	M									
CO3		S										
CO4		S										
CO5	S			M								
CO6	S										M	

COURSE ASSESSMENT METHODS
DIRECT
1. Continuous Assessment Test I, II
2. Assignment
3. Demonstration etc (as applicable)
4. End Semester Examination
INDIRECT
1.Course-end survey

INTRODUCTION	9 Hours

Operating System - Operating System Structure – Operations – Process Management – Memory Management-Secondary Storage Management – Protection and Security – Open Source Operating System – Operating System Services – User Interface – System Calls – System Programs – Design and Implementation – Debugging.

PROCESS MANAGEMENT	8 Hours

Process Concepts – Process Scheduling – Operations on Processes – Inter Process Communication – Examples – Threads – Overview – Multi Threading Models – Libraries – Issues.

PROCESS SYNCHRONIZATION	7 Hours

Background – Critical Section Problem – Peterson's Solution – Synchronization Hardware – Semaphores – Classic Problem of Synchronization – Monitors.

CPU SCHEDULING	6 Hours

Basic Concepts – Scheduling Criteria – Scheduling Algorithms - Problems

DEADLOCK	6 Hours

Deadlock Characterization – Handling Deadlocks – Deadlock Prevention – Avoidance – Detection – Recovery.

MEMORY MANAGEMENT	6 Hours

Background – Swapping – Contiguous Memory Allocation – Paging – Structure of the Page Table – Segmentation -Virtual Memory Management - Background – Demand Paging – Copy on Write – Page Replacement – Thrashing – Working Set.

I/O MANAGEMENT, DISK SCHEDULING AND FILE MANAGEMENT	5 Hours

Organization of I/O function – Evolution of I/O Function – Types of I/O devices – Logical Structure of I/O Functions – I/O Buffering – Disk I/O – Disk Scheduling Algorithms – Disk Cache. File Concept – Access Methods-Free Space management

VIRTUAL MACHINES	4 Hours

System Model – Implementation of Virtual Machines-Benefits and Features -Building Block - Types of Virtual Machines - Virtualization and Operating-System Components.

CASE STUDY	9 Hours

Linux System - Design Principles, Kernel Modules, Process Management, Scheduling, Memory Management, Input-Output Management, File System, Inter-process Communication; Mobile OS - iOS and Android - Architecture and SDK Framework, Media Layer, Services Layer, Core OS Layer. File System- Google File System-Ocean Store.

-

Theory: 45 Hrs Tutorial: 15 Hrs	Total Hours: 60 Hrs

REFERENCES

1. Abraham Silberschatz, Peter B. Galvin, "Operating System Concepts", 10thEdition, John Wiley & Sons, Inc., 2018.
2. P.C.Bhatt, "An Introduction to Operating Systems–Concepts andPractice",4th Edition, Prentice Hall of India., 2013.
3. William Stallings, "Operating Systems: Internals and Design Principles",9th Edition, Prentice Hall of India., 2018.
4. D.M.Dhamdhere, "Operating Systems: A Concept based Approach", 3rdEdition, Tata McGraw Hill, 2017.

P20CAT1004	PROGRAMMING WITH JAVA	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Apply the fundamental core java, packages, database connectivity for computing.
CO2: Implement Java programs.
CO3: Make use of hierarchy of Java classes to provide a solution to a given set of requirements.
CO4: Use the frameworks JSP, Hibernate, Spring.
CO5: Design and implement server-side programs using Servlets and JSP.

Pre–requisite **:**Nil

Cos	PROGRAMME OUTCOMES (POs) (S/M/W Indicates Strength of Correlation) S-Strong, M-Medium, W- Weak											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	M	S		M		M					
CO2	S		S		M							
CO3	S		M		M							
CO4	S		M		S							M
CO5			M		M							M

COURSE ASSESSMENT METHODS

DIRECT

1. Continuous Assessment Test I, II
. 2. Assignment
. 3. Demonstration etc (as applicable)
. 4. End Semester Examination

INDIRECT

1.Course-end survey

JAVA FUNDAMENTALS	9 Hours

Java features – Java Platform – Java Fundamentals – Expressions, Operators, and Control Structures – Classes, Methods – Inheritance - Packages and Interfaces – Boxing, Unboxing – Variable-Length Arguments (Vararg), Exception Handling.

COLLECTIONS AND ADVANCE FEATURES	9 Hours

Utility Packages- Introduction to Collection –Hierarchy of Collection Framework – Generics, Array list, LL, HashSet, Tree-set, HashMap – Comparators – Java annotations – Pre-main method.

ADVANCED JAVAPROGRAMMING	9 Hours

Input Output Packages – Inner Classes – Java Database Connectivity - Introduction JDBC Drivers - JDBC Connectivity with MySQL/Oracle -Prepared Statement and Result Set – JDBC Stored Procedures Invocation - Servlets - RMI – Lambda Expressions.

OVERVIEW OF DATA RETRIEVAL AND ENTERPRISE APPLICATION DEVELOPMENT	**8 Hours**

Tiered Application development - Java Servers, Containers –Web Container – Creating Web Application using JSP/Servlets – Web Frameworks- Introduction to Spring and Spring Boot- Play Framework – ORM Layer – Introduction to Hibernate.

JAVA INTERNALS AND NETWORKING	**10 Hours**

Java Jar Files-Introspection – Garbage Collection – Architecture and Design – GC Cleanup Process, Invoking GC, Generation in GC - Networking Basics Java and the Net – InetAddress – TCP/IP Client Sockets – URL –URL Connection – TCP/IP Server Sockets – A Caching Proxy HTTP Server – Datagrams.

Theory: 45 Hours	**Tutorial: -**	**Total: 45 Hours**

REFERENCES:

1. Amritendu De, "Spring 4 and Hibernate 4: Agile Java Design and Development", McGraw-Hill Education, 2015.
2. Herbert Schildt, "The Complete Reference – Java 2", Ninth Edition, Tata McGraw Hill, 2014.
3. Joyce Farrell, "Java Programming", Cengage Learning, Seventh Edition, 2014.
4. John Dean, Raymond Dean, "Introduction to Programming with JAVA – A Problem Solving Approach", Tata Mc Graw Hill, 2014.
5. Mahesh P. Matha, "Core Java A Comprehensive Study", Prentice Hall of India, 2011.
6. R. Nageswara Rao, "Core Java: An Integrated Approach", Dream Tech Press, 2016.

P20MAT1101	PROBABILITY AND STATISTICS FOR DATA ANALYSIS	L	T	P	J	C
		3	1	0	0	4

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Understand about data collection, represent data graphically using bar chart and pie chart. and compute various measures of central tendency and dispersion for analysis of data.

CO2: Interpret the correlation between variables and predict unknown values using regression.

CO3: Explore random variables and predict probabilities for situations following normal distribution.

CO4: Perform hypothesis testing using large sample tests and Chi square test and interpret the results, which will form the basis for data analysis.

CO5: Understand the principles of design of experiments and perform analysis of variance.

Pre–requisite : Nil

Cos	PROGRAMME OUTCOMES (POs) (S/M/W Indicates Strength of Correlation) S-Strong, M-Medium, W- Weak											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	S										M
CO2	M	M										
CO3	W	W										
CO4	W	W										
CO5	W	W										

COURSE ASSESSMENT METHODS

DIRECT

1. Continuous Assessment Test I, II
2. Assignment
3. Assignment based on R Software
4. End Semester Examination

INDIRECT

1. Course-end survey

COLLECTION OF DATA AND STATISTICAL MEASURES	13+4 Hours

Collection of Data-Classification-Tabulation-Graphical Representation – Simple Bar Chart – Pie Chart - Measures of Central Tendency: Arithmetic Mean, Median and Mode – Measures of Variation: Range, Quartile Deviation - Standard Deviation and Coefficient of Variation – Five Number Summary – Box Plot Technique.

CORRELATION AND REGRESSION	7+3 Hours

Correlation (Discrete Data) – Scatter Diagram - Karl Pearson's Correlation Coefficient – Spearman's Rank Correlation – Regression Lines (Discrete Data).

RANDOM VARIABLES	**11+3 Hours**

Random Variable – Distribution Function – Properties – Probability Mass Function – Probability Density Function – Expectation - Normal Distribution.

TESTING OF HYPOTHESIS	**7+3 Hours**

Testing of Hypothesis for Large Samples (Single Mean, Difference of Means, Single Proportion, Difference of Proportions) - Chi-Square Test for Independence of Attributes.

ANALYSIS OF VARIANCE	**7+2 Hours**

Analysis of Variance (ANOVA) – Completely Randomized Design (CRD) – Randomized Block Design (RBD) – Latin Square Design (LSD).

Theory: 45 Hours	**Tutorial: 15 Hours**	**Total: 60 Hours**

STATISTICAL LAB USING R-PROGRAMMING (Self-Study Mode)

List of Experiments

1. Introduction, Basic data representation.
2. Data presentation methods - Bar Chart, Pie Chart.
3. Importing data from MS-Excel.
4. Data manipulation
5. Mean, median, mode.
6. Standard deviation, five number summary, box plot.
7. Scatter diagram, correlation.

REFERENCES

1. Devore, J.L., "Probability and Statistics for Engineering and Sciences", 8th Edition, Cengage Learning Pvt. Ltd., New Delhi, 2014.
2. Johnson, R.A and Gupta C. B., "Miller and Freund's Probability and Statistics for Engineers", Pearson Education Int., Asia, 9th Edition, 2017.
3. Lipschutz, S. "Probability and Statistics", 4th Edition, McGraw Hill, New Delhi, 2010.
4. Walpole. R.E., Myers. R.H., Myers. S.L. and Ye. K., "Probability and Statistics for Engineers and Scientists", Pearson Education, Asia, 9th Edition, 2012.
5. Gareth M. James, Daniela Witten, Trevor Hastie, Robert Tibshirani, An Introduction to Statistical Learning: With Applications in R, 2017.
6. Milton. J. S. and Arnold. J.C., "Introduction to Probability and Statistics", Tata McGraw Hill, 4th Edition, 2007
7. Gupta S. P, Statistical Methods, Sultan Chand & Sons Publishers, 2014.

P20CAP1501	DATABASE TECHNOLOGIES LABORATORY	L	T	P	J	C
		0	0	4	0	2

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Design and implement a database schema for a given problem domain.

CO2: Construct simple and advanced database queries using Structured Query Language (SQL).

CO3: Populate and query a database using TCL/DCL commands.

CO4: Program in PL/SQL including stored procedures, stored functions, cursors and packages.

CO5: Design and build a GUI application using 4GL.

Pre–requisite :Nil

Cos	PROGRAMME OUTCOMES (POs) (S/M/W Indicates Strength of Correlation) S-Strong, M-Medium, W- Weak											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	M	M									
CO2	S		W									
CO3	S											
CO4	S	M	M									
CO5	S	M	S		M	M						

COURSE ASSESSMENT METHODS

DIRECT

1. Pre/Post - Experiment Test/Viva; Experimental Report for each Experiment
2. Model Examination
3. End Semester Examination

INDIRECT

1.Course-end survey

LIST OF EXPERIMENTS:

1. Execute Data Definition Language and Data Manipulation Language commands.
2. Demonstrate Data Control Language and Transaction Control Language commands.
3. Implement Data Query Language.
4. Execute SQL Functions.
5. Evaluate Set Operations.
6. Implement Join Operations.
7. Execute Complex and Sub Queries.
8. Create Database Objects.
9. Execution of PL/SQL Commands.
10. Record Management using Cursors.
11. Construct Functions.

12. Create Triggers.
13. Exercise of nested table using PL/SQL.
14. Develop a Package using Database Connectivity.
15. Exercise using NoSQL Database.

Total Hours: 60 Hours

P20CAP1502	DATA STRUCTURES LAB USING C	L	T	P	J	C
		0	0	4	0	2

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Develop skills to design and analyze simple linear and nonlinear data structures.

CO2: Design and analyze the time and space efficiency of the data structures.

CO3: Apply the suitable data structure for any given real-world problem.

CO4: Gain knowledge in practical applications of data structures.

COURSE ASSESSMENT METHODS

Pre–requisite : Nil

Cos	PROGRAMME OUTCOMES (POs) (S/M/W Indicates Strength of Correlation) S-Strong, M-Medium, W- Weak											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	M	M				M					
CO2	M	W		M			M					
CO3	M		M									
CO4		S	S				M		W			

COURSE ASSESSMENT METHODS

DIRECT

1. Pre/Post - Experiment Test/Viva; Experimental Report for each Experiment
2. Model Examination
3. End Semester Examination

INDIRECT

1.Course-end survey

LIST OF EXPERIMENTS:

1. Implement linear and binary search in an array.
2. Create a linked list and implement its operations.
3. Implement Stack using array.
4. Implement Stack using linked list.
5. Implement Queue using array.
6. Implement Queue using linked list.
7. Implement Quick sort using recursion.
8. Implement Merge sort using recursion.
9. Implement a binary search tree.
10. Implement the tree traversals on a binary search tree.
11. Implement breadth first and depth first traversals in a graph.
12. Implement Warshall's algorithm for transitive closure.
13. Implement shortest path algorithms.

Total : 60 hours

P20CAP1503	PROGRAMMING WITH JAVA LAB	L	T	P	J	C
		0	0	4	0	2

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Implement object-oriented features using Java.
CO2: Create interfaces, packages and apply exception handling.
CO3: Implement RMI and servlet programs.
CO4: Create applications using JDBC, JSP and Frameworks.

Pre–requisite : Nil

Cos	PROGRAMME OUTCOMES (POs) (S/M/W Indicates Strength of Correlation) S-Strong, M-Medium, W- Weak											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	M	M				S	M				
CO2	M	M	M		M		S					
CO3	M	M	M	M	M			M				
CO4	M	S	S	S	S							

COURSE ASSESSMENT METHODS
DIRECT
1. Pre/Post - Experiment Test/Viva; Experimental Report for each Experiment
2. Model Examination
3. End Semester Examination
INDIRECT
1.Course-end survey

LIST OF EXPERIMENTS:

1. Program to illustrate declaration and access control.
2. Program to illustrate assignments.
3. Program to illustrate the use of operators.
4. Program to illustrate flow control.
5. Program to implement various OOPS concepts.
6. Program to illustrate APIs like collection, I/O etc.
7. Program to implement the concept of interfaces and packages.
8. Program to implement exceptions handling mechanism.
9. Program using applets.
10. Program to illustrate the use of RMI (Remote Method Invocation).
11. Create an applications using Servlet.
12. Perform database connectivity using JDBC.
13. Use JSP tag to create an application.
14. Illustrate an application using Spring.
15. Develop applications using Hibernate.

Total : 60 hours

SEMESTER – II

P20CAT2001	SOFTWARE ENGINEERING METHODOLOGIES AND QUALITY ASSURANCE	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO 1: Get an insight into the processes of software development.

CO 2: Understand the problem domain and modeling.

CO 3: Apply design techniques software products.

CO 4: Implement software quality management concepts.

CO 5: Apply software testing techniques for information systems development

Pre–requisite **:** Nil

Cos	PROGRAMME OUTCOMES (POs) (S/M/W Indicates Strength of Correlation) S-Strong, M-Medium, W- Weak											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	M			M		W				M	
CO2	M	S			M						W	
CO3	M		S		S						M	
CO4	S		M								M	
CO5		M			S						M	

COURSE ASSESSMENT METHODS
DIRECT
1. Continuous Assessment Test I, II
2. Assignment; Group Presentation
3. End Semester Examination
INDIRECT
1.Course-end survey

INTRODUCTION	9 Hours

Introduction to Software Engineering – A Generic Process Model – Prescriptive Process Models: Waterfall, Incremental, Prototyping, and Spiral Model – The Unified Process – Introduction to Agile and Scrum methodologies.

MODELING	9 Hours

Understanding Requirements – Scenario Based Requirements Modeling, Data Modeling Concepts, Class Based Requirements Modeling.

SOFTWARE DESIGN	9 Hours

Design Concepts – Design Models – Architectural Design: Software Architecture – Architectural Styles – Architectural Design – Component Level Design: Component – Designing Class Based Components

QUALITY MANAGEMENT	9 Hours
Quality Concepts – Achieving Software Quality – Review Techniques – Software Configuration Management (SCM) – SCM Repository – SCM Process – Software Maintenance and Supportability.	

SOFTWARE TESTING	9 Hours
Unit Testing – Integration Testing – System Testing: Performance, Load, Stress, Security, Recoverability, Compatibility Testing – Regression Testing – Installation Testing – Usability Testing – Acceptance Testing – Alpha Testing and Beta Testing – Static vs. Dynamic Testing – Manual vs. Automatic Testing – Black Box Testing – White Box Testing.	

Theory: 45 Hours	Tutorial: -	Total Hours: 45 Hours

REFERENCES

1. Roger Pressman S, "Software Engineering: A Practitioner's Approach", 8th Edition, Tata McGraw Hill, 2019.
2. Shari Lawrence Pfleeger & Joanne M. Atlee, "Software Engineering", Pearson Education, 2010.
3. Ron Patton, "Software Testing", 2nd Edition, Pearson Education, 2009.
4. Carlo Ghezzi, Mehdi Jazayari& Dino Mandrioli, "Fundamentals of Software Engineering", Prentice Hall of India, 2010.
5. Ian Sommerville, "Software Engineering", 10th Edition, Pearson Education, 2015.
6. Watts S. Humphrey, "Managing the Software Process", Addison Wesley, 1999

P20CAI2202	WEB TECHNOLOGIES	L	T	P	J	C
		3	0	2	0	4

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Create a basic website using HTML and Cascading Style Sheets.

CO2: Design and implement dynamic web page with validation using JavaScript objects and by applying different event handling mechanisms.

CO3: Design rich client presentation using AJAX.

CO4: Design and implement simple web page to present data in XML format.

CO5: Design front end web page and connect to the back-end databases.

Pre–requisite : Nil

Cos	PROGRAMME OUTCOMES (POs) (S/M/W Indicates Strength of Correlation) S-Strong, M-Medium, W- Weak											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	W	S		S		S					
CO2		M	S		S		S					
CO3	M	W	S		S		S					
CO4		M	S		S		S					
CO5	M		S		S		S					

COURSE ASSESSMENT METHODS

DIRECT

1.Continuous Assessment Test I, II (Theory component)

2.Assignment (Theory component)

3. Demonstration etc (as applicable) (Theory component)

4. Pre/Post - Experiment Test/Viva; Experimental Report for each Experiment (lab Component)

5.Model Examination (lab component)

6.End Semester Examination (Theory and lab components)

INDIRECT

1.Course-end survey

WEB FUNDAMENTALS AND XHTML	5 Hours

Web browsers, web servers, MIME, URL, HTTP. Introduction to XHTML5 tags, Basic syntax and structure, text markups, images, lists, tables, Media tags-audio and video, forms, frames.

UI DESIGN	10 Hours

Markup Language (HTML5): Basics of Html -Syntax and Tags of Html- Introduction to HTML5 -Semantic/Structural Elements -HTML5 Style Guide and Coding Convention– Html Svg and Canvas – Html API"s - Audio & Video - Drag/Drop - Local Storage - Web Socket API– Debugging and Validating Html.

Cascading Style Sheet (CSS3): The Need for CSS – Basic Syntax and Structure Inline Styles – Embedding Style Sheets - Linking External Style Sheets - Introduction to CSS3 – Backgrounds - Manipulating text - Margins and Padding - Positioning Using CSS -Responsive Web Design - Introduction to LESS/SASS

JAVASCRIPT	9 Hours

Introduction to JavaScript, controls statements, Arrays and functions, pattern matching, Element Access, Event Handling.

BOOTSTRAP	6 Hours

Introduction to Bootstrap, First example, containers, Bootstrap elements: colors, tables, images, buttons, button groups, progress bars, Forms, utilities, Classes, alerts, custom forms, Grid System.

JQUERY	6 Hours

Introduction to JQuery, Syntax, selectors, events, JQuery HTML, JQuery Effects, JQuery CSS.

ANGULAR JS	9 Hours

Introduction to Angular JS, Directives, Expressions, Directives, Controllers, Filters, Services, Events, Forms, Validations, Examples.

Theory: 45 Hours	Tutorial: -	Total: 45 Hours

List of Experiments :
1. Create a web page with the following using HTML5
   a) To embed an image map in a web page
   b) To fix the hot spots
   c) Show all the related information when the hot spots are clicked.
2. Create a web page with all types of Cascading style sheets.
3. Implement Client-Side Scripts for Validating Web Form Controls using JavaScript
4. Designing Quiz Application Personal Information System/ Using JavaScript
5. Write a JavaScript for Loan Calculation.
6. Write a JavaScript to design a simple calculator to perform the following operations: sum, product, difference and quotient.
7. Develop and demonstrate a HTML file that includes JavaScript that uses functions for the following problems:
   a) Parameter: A string Output: The position in the string of the left-most vowel
   b) Parameter: A number Output: The number with its digits in the reverse order
8. Write a JavaScript that calculates the squares and cubes of the numbers from 0 to 10 and outputs HTML text that displays the resulting values in an HTML table format.
9. Write an AJAX program for parsing a JSON file and formatting the output.
10. Create an online Event Registration form and validate using JQuery

REFERENCES

1. Chris Bates, "Web Programming-Building Internet Applications", 3rd, 2006, John Wiley & Sons.

2. Harvey & Paul Deitel & Associates, Harvey Deitel and Abbey Deitel, "Internet and World Wide Web -How To Program", Fifth Edition, Pearson Education, 2011.
3. DT Editorial Services, "HTML5 Black Book",2016, Dreamtech Press.
4. Krishna Rungta,"Learn AngularJS in 1 Day: Complete Angular JS Guide with Examples", Independent Publication,2018.
5. Snig Bhaumik,"Bootstrap essentials", Packt-open source,2015.
6. David Flanagan, "JavaScript: The Definitive Guide, Sixth Edition", O'Reilly Media, 2011.
7. James Lee, BrentWare , "Open Source Development with LAMP: Using Linux, Apache, MySQL, Perl, and PHP" Addison Wesley, Pearson 2009.
8. Thomas A. Powell, "HTML & CSS: The Complete Reference", Fifth Edition, 2010.
9. Thomas A Powell, Fritz Schneider, "JavaScript: The Complete Reference", Third Edition, Tata McGraw Hill, 2013.
10. Thomas A Powell, "Ajax: The Complete Reference", McGraw Hill, 2008.

Total: 30 Hours

P20CAT2003	DATA INTENSIVE COMPUTING	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Understand the fundamentals of Data Mining and Pre-processing
CO2: Apply the regression and classification techniques
CO3: Evaluate the models using performance metrics
CO4: Cluster the high dimensional data and apply the association rules for mining the data
CO5: Apply various methods to detect outliers
CO6: Implement the text analysis

Pre–requisite : Nil

Cos	PROGRAMME OUTCOMES (POs) (S/M/W Indicates Strength of Correlation) S-Strong, M-Medium, W- Weak											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	M		M							W	
CO2	M	S		S	M							
CO3	S	M		S								
CO4	S	M		S	M						M	
CO5	M	S	M		M							
CO6	S			M	S							

COURSE ASSESSMENT METHODS
DIRECT
1. Continuous Assessment Test I, II
2. Assignment; Group Presentation
3. End Semester Examination
INDIRECT
1.Course-end survey

INTRODUCTION	3 Hours
Data Mining – Kinds of Data Mined – Functionalities – Technologies – Applications – Issues – Getting to Know the Data – Types of Data Sets and Attribute Values.	

DATA PRE-PROCESSING	3 Hours
Introduction - Need for Data Pre-processing – Data Cleaning – Data Integration and Transformation – Data Reduction – Data Discretization and Concept Hierarchy Generation.	

SUPERVISED LEARNINGTECHNIQUES	9 Hours
Basic Concepts – Decision Tree – Naïve Bayes Classification – Bayesian Belief Networks – Back propagation – Support Vector Machines – Linear Regression – Logistic Regression	

MODEL EVALUATION AND SELECTION	5 Hours
Metrics for Evaluating Classifier Performance - Holdout Method and Random Sub sampling - Cross-Validation –ROC Curves - Techniques to Improve Classification Accuracy: Bagging – Boosting – Random Forest	
UNSUPERVISED LEARNING TECHNIQUES	9 hours
Association Rule Mining - Market Basket Analysis - Apriori algorithm - FP-growth - Cluster Analysis - K-Means - *k*-Medoids - Distance Measures - Expectation-Maximization Algorithm - Subspace Clustering Methods – Bi-clustering - Clustering Graph and Network Data	
EVALUATION OF CLUSTERING	3 Hours
Assessing Clustering Tendency - Determining the Number of Clusters - Measuring Clustering Quality	
OUTLIER ANALYSIS	5 Hours
Introduction – Types of Outliers - Outlier Detection Methods: Statistical Approaches - Clustering-Based Approaches - Classification-Based Approaches	
TEXT ANALYSIS	5 Hours
Overview – Collecting Raw Text – Representing Text – Text Frequency – Categorizing Documents – Determining Sentiments – Gaining Insights	
DATA VISUALIZATION	3 Hours
Key Points supported with Data – Evolution of a Graph – Common Representation Methods – Clean up a Graphics	

Theory: 45 Hours	Tutorial: -	Total : 45 Hours

REFERENCES:

1. EMC Education Services, "Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data Big data science &Analytics : a hands-on approach", Wiley, 2015
2. Jiawei Han and Micheline Kamber, "Data Mining Concepts and Techniques" Third Edition, Elsevier, Reprinted 2012
3. Jared Dean, "Big Data, Data Mining, and Machine Learning: Value Creation for Business Leaders and Practitioners", Wiley, USA, 2014.
4. Andreas C. Müller & Sarah Guido, "Introduction to Machine Learning with Python A Guide for Data Scientists" O'Reilly book, 2017
5. Nataraj Dasgupta, Practical Big Data Analytics: Hands-on techniques to implement enterprise analytics and machine learning using Hadoop, Spark, NoSQL and R, Packt 2018.

P20CAT2004	DATA COMMUNICATIONS AND NETWORKS	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Identify the various computer network components, protocol design models and the usage of various types of transmission media and working of LAN technology.

CO2: Understand the IP addressing schemes, routing protocols, congestion control and flow control concepts.

CO3: Identify the components required to build different types of networks

CO4: Understand the network applications and protocols and network security.

CO5: Familiarize with recent trends in computer network implementations.

Pre–requisite : Nil

Cos	PROGRAMME OUTCOMES (POs) (S/M/W Indicates Strength of Correlation) S-Strong, M-Medium, W- Weak											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1							M				M	M
CO2	S	S	M									
CO3							M					W
CO4	W					M						
CO5		M			M							

COURSE ASSESSMENT METHODS
DIRECT
1.Continuous Assessment Test I, II
2.Assignment; Group Presentation
3.End Semester Examination
INDIRECT
1.Course-end survey

INTRODUCTION	9 Hours

Introduction – Data Communication - Network Models – OSI Model – Layers in the OSI Model – TCP/IP Protocol Suite – Transmission Media –Switching – Circuit and Packet SwitchedNetworks – Datagram Networks –Virtual Circuit Networks – Data Link Layer - Error Detection and Correction – Data Link Control – Medium Access Control – Wired and Wireless LANs – Connecting Devices – Virtual LANs.

INTERNETWORKING	9 Hours
Packet Switching – Network Layer Performance – Logical Addressing – IPv4 Addresses – IPv6 Addresses – Internet Protocol – IPv4 – IPv6 – ICMP v4 – Mobile IP – Unicast Routing.	
RELIABILITY AND QUALITY OF SERVICE	**9 Hours**
Process–to–Process Delivery – Protocols – User Datagram Protocol (UDP) – Transmission Control Protocol(TCP) – Congestion Control and Quality of Service (QoS).	
NETWORK APPLICATIONS AND SECURITY	**9 Hours**
Domain Name System(DNS) – Name Space – DNS – Distribution of Name Space – DNS in the Internet – Resolution – DNS Messages – Types of Records – Remote Logging – Electronic Mail – Simple Mail Transfer Protocol(SMTP) – File Transfer – World Wide Web(WWW) –Secure Shell-Hyper Text Transfer Protocol(HTTP) – Simple Network Management Protocol(SNMP) –Security – Cryptography and Network Security.	
RECENT TRENDS	**9 Hours**
Software Defined Networks Overlay model and network model for cloud computing Network Functions Virtualization Concepts, Benefits, requirements, References architecture – Network Virtualization - Network Virtualization Architecture and Benefits	

Theory: 45 Hours	Tutorial: -	Total : 45 Hours

REFERENCES

1. Behrouz A. Forouzan, "Data Communication and Networking", 5th Edition, Tata McGraw Hill, 2013.
2. Andrew S.Tanenbaum, "Computer Networks", 5th Edition, Prentice Hall, 2011.
3. Larry L. Peterson & Bruce S. Davie, "Computer Networks: A Systems Approach", 5th Edition, Morgan Kaufmann Publishers, 2014.
4. James F. Kurose & Keith W. Ross "Computer Networking: A Top-Down Approach", 6th Edition. Pearson, 2017.

P20CAP2501	DATA INTENSIVE COMPUTING LAB USING PYTHON	L	T	P	J	C
		0	0	4	0	2

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Understand about the problem solving in real-world machine learning applications.

CO2: Implement the supervised learning principles and concepts through python.

CO3: Implement various unsupervised methods

CO4 :Evaluate Machine Learning Algorithms

Pre–requisite : Nil

Cos	PROGRAMME OUTCOMES (POs) (S/M/W Indicates Strength of Correlation) S-Strong, M-Medium, W- Weak											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		S		M			M				W	
CO2	S	M	S		M							
CO3	S	M	S		M							
CO4	M			S	M						M	

COURSE ASSESSMENT METHODS

DIRECT

1. Pre/Post - Experiment Test/Viva; Experimental Report for each Experiment
2. Model Examination
3. End Semester Examination

INDIRECT

1.Course-end survey

List of Experiments:

1. Write a Python program to load the dataset into a data frame and print the shape of the data, type of the data, number of rows-columns, feature names and the description

2. Write a Python program to get the number of observations, missing values and Null values for the given data set.

3. Write a python program to implement various pre-processing techniques in the dataset.

4. Write a Python program to split the dataset into Training and Testing data. Fit the data into the model and calculate the performance measures using Decision Tree.

5. Write a program to implement the naïve Bayesian classifier for a sample training data set. Compute the accuracy of the classifier, considering few test data sets.

6. Build an Artificial Neural Network by implementing the Backpropagation algorithm and test the same using appropriate data sets.

7. Implement support vector machine for the given data set.

8. Implement the K-Means algorithm for the given data set. Evaluate the performance using various K values.

9. Implement EM algorithm for the given data set.

10. Implement Apriori algorithm and generate the association rules.
11. Write a python program to implement linear and logistic regression.
12. Evaluate the various model using performance metrics and find the find best model for the given dataset.
13. Implement a Python program to analyze the text in the document.

Total: 60 hours

P20CAI2603	ENGINEERING CLINICS	L	T	P	J	C
		0	0	2	2	2

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Understand and explain the functionality of IoT and cloud concepts

CO2: Design and build simple IoT projects

CO3: Ability to work as a team and apply the IoT and cloud concepts in their own design
    Project/innovate a viable product

Pre–requisite : Nil

Cos	PROGRAMME OUTCOMES (POs) (S/M/W Indicates Strength of Correlation) S-Strong, M-Medium, W- Weak											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S			S								
CO2		S	S							M		
CO3					S						S	S

List of Experiments:

1. Basics of ARDUINO and IoT

2. Working with LEDs & Digital Switch

3. Adjusting voltage using potentiometer, to find the distance of an object using ultrasonic Sensor

4. Finding the Temperature and Humidity in the surroundings &Detecting the motion of human using PIR

5. Working with Servo motor

6. Establish communication using Bluetooth

7. Examples of Software-as- a-Service (SaaS), Platform-as- a-Service (PaaS), Infrastructure-as- a-Service (IaaS)

8. Creation of virtual Firewall

9. Creation of VM backup

10. Deployment of VMs in Oracle Virtual box

11. Install storage controller and interact with it

12. Hosting Web application in cloud

Total: 30 hours

SEMESTER III

P20CAI3201	SERVICE ORIENTED ARCHITECTURE	L	T	P	J	C
		3	0	2	0	4

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Get the foundations and concepts of service-based computing.

CO2: Understand service - oriented analysis techniques.

CO3: Understanding the basic operational model of web services.

CO4: Gain the knowledge of key technologies in the service-oriented computing arena.

CO5: Apply and practice the learning through a real or illustrative project/case study.

Pre–requisite : Nil

Cos	PROGRAMME OUTCOMES (POs) (S/M/W Indicates Strength of Correlation) S-Strong, M-Medium, W- Weak											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S			M	M		M					
CO2	M	S		M	W							
CO3	W		S	M	M	M				M		
CO4		W		M	S	M	M					
CO5		S	S	S	S	S						

COURSE ASSESSMENT METHODS

DIRECT

1. Continuous Assessment Test I, II (Theory component)

2. Assignment (Theory component)

3. Demonstration etc (as applicable) (Theory component)

4. Pre/Post - Experiment Test/Viva; Experimental Report for each Experiment (lab Component)

5. Model Examination (lab component)

6. End Semester Examination (Theory and lab components)

INDIRECT

1. Course-end survey

INTRODUCTION	**5 Hours**

SOA and MSA Basics- Service Orientation in Daily Life- Evolution of SOA and MSA- Service oriented Architecture and Microservices architecture – Drivers SOA- Dimensions of SOA- Conceptual Model of SOA- Standards and Guidelines for SOA-Emergence of MSA

SERVICE ORIENTED ARCHITECTURE	**10 Hours**

Enterprise-Wide SOA-Considerations for Enterprise-wide SOA- Strawman Architecture for Enterprise-wide SOA- Enterprise SOA Reference Architecture- Object-oriented Analysis and Design (OOAD) Process- Service oriented Analysis and Design (SOAD) Process - SOA Methodology for Enterprise. Service-Oriented Applications: Considerations for Service-oriented Applications- Patterns for SOA-Patternbased Architecture for Service-oriented Applications -Composite Applications - Programming Model.

SERVICE-ORIENTED ANALYSIS AND DESIGN	10 Hours

Need for Models- Principles of Service Design- Non-functional Properties for Services- Design of Activity Services - Design of Data Services- Design of Client Services - Design of Business Process Services. Technologies for SOA: Technologies for Service Enablement - Technologies for Service Integration- Service Orchestration - SOA Governance and Implementation: Strategic Architecture Governance -Service Design- Time Governance - Service Run-time Governance- Approach for Enterprise-wide SOA Implementation.

BIG DATA AND SOA	10 Hours

Concepts - Big Data and its characteristics - Technologies for Big Data -Service-Orientation for Big Data Solutions - Business Case for SOA - Stakeholder Objectives - Benefits of SOA - Cost Savings - Return on Investment (ROI) - Build a Case for SOA - SOA Best Practices: SOA Strategy – Best Practices- SOA Development – Best Practices- SOA Governance – Best Practices- EA and SOA for Business and IT Alignment: Enterprise Architecture- Need for Business and It Alignment- EA and SOA for Business and Its Alignment.

MICROSERVICES ARCHITECTURE	10 Hours

Trend in SOA: Microservices Architecture (MSA)- Services Model for Cloud and Mobile Solutions - API Adoption on the Rise - Challenges and Takeaways from SOA Implementations- Architecture Trend – Microservices Architecture – Microservices Architecture in Action. Cloud and MSACloud Services-Hybrid Cloud Services- Considerations for Hybrid Cloud Services-Cloud Services and MSA-MSA for SMAC Solutions. Mobile and MSA: Mobile Technologies-Types of Mobile Applications-MSA for mobile solutions.

Theory: 45 Hours	Tutorial: -	Total : 45 Hours

LIST OF EXPERIMENTS

1. Program to create an application for illustrating SOAP based web service.
2. Program to create an application for illustrating RESTful web service.
3. Program to create different modules in various programming languages and wire them using ESB.
4. Program to create a process template using web service Business Process Execution Language.
5. Program to enable security for web service with HTTPS/SOAP.
6. Program to enable security for web service with digital signature.
7. Program based on Microservices Architecture & Implementation.

Total :30 Hours

REFERENCES

1. Shankar Kambhampaty; Service - Oriented Architecture & Microservices Architecture: For Enterprise, Cloud, Big Data and Mobile, Wiley,3rd Edition, 2018.
2. Thomas Erl, "Service-Oriented Architecture: Concepts, Technology, and Design", Pearson Education, 2016.
3. Frank. P. Coyle, "XML, Web Services And The Data Revolution", Pearson Education, 2002.
4. Sandeep Chatterjee, James Webber, "Developing Enterprise Web Services. An Architect's Guide", Pearson Education, 2005.
5. Newcomer, Lomow, "Understanding SOA with Web Services", Pearson Education, 2005.
6. Dan woods and Thomas Mattern, "Enterprise SOA designing IT for Business Innovation", O'REILLY, First Edition, 2006.
7. Rajkumar Buyya, Christian Vecchiola, S. ThamaraiSelvi, "Mastering Cloud Computing", McGraw Hill Education, 2013.

P20CAT3002	ETHICS IN COMPUTING	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Examine situations and to internalize the need for applying ethical principles, values to tackle with various situations.

CO2: Express the aspects of computer crime, code of ethics and standards of computer professionals.

CO3: Show a responsible attitude towards the use of computer as well as the technology.

CO4: Understand ethical issues in software development and social networking.

CO5: Analyse the professional responsibility and empowering access to information in the work.

Pre–requisite: Nil

Cos	PROGRAMME OUTCOMES (POs) (S/M/L Indicates Strength of Correlation) S-Strong, M-Medium, L- Less											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1			W			M		S				
CO2		M				M		S				
CO3			W		W	M	M					
CO4	W					M		S		W		
CO5	M						M		W			

COURSE ASSESSMENT METHODS

DIRECT

1. Continuous Assessment Test I, II
2. Assignment, Group Presentation
3. End Semester Examination

INDIRECT

1. Course-end survey

INTRODUCTION TO COMPUTER ETHICS	7 Hours

Definition of Ethics - Ethics in Business World- IT Professionals - IT Users.

ASPECTS OF COMPUTER CRIME AND INTELLECTUAL PROPERTY RIGHTS	10 Hours

Types of Exploits and Perpetrators– Implementing Trustworthy Computing- Intellectual Property Rights – Copyrights– Patents- Trade Secrets- Key Intellectual Property Issues.

PRIVACY AND FREEDOM OF EXPRESSION	10 Hours

Privacy Protection and Law – Privacy and Anonymity Issues- First Amendment Rights – Freedom of Expression: Key Issues.

SOFTWARE DEVELOPMENT AND SOCIAL NETWORKING	10 Hours
Software Development – Strategies for Engineering Quality Standards–Software Product Liability – Key Issues in Software Development- Social Networking –Business Applications of Online Social Networking– Social Networking Ethical Issues – Online Virtual World.	

ETHICS OF IT ORGANIZATIONS	8 Hours
Ethical Issues for Organizations- Contingent Workers –Outsourcing – Whistle Blowing – Green Computing - ICT Industry Code of Conduct.	

Theory: 45 Hrs	**Tutorial: Nil**	**Total Hours: 45Hrs**

REFERENCES

1. George W. Reynolds, "Ethics in Information Technology", Cengage Learning, 6th Edition, 2018.
2. Sara Baase, "A Gift of Fire: Social, Legal, and Ethical Issues for Computing and the Internet", 4th Edition, Prentice Hall, 2018.
3. Penny Duquenoy, Simon Jones and Barry G Blundell, "Ethical, legal and professional issues in Computing", Middlesex University Press, 2008.
4. Caroline Whitback, "Ethics in Engineering Practice and Research", Cambridge University Press, 2011.

P20CAI3203	CLOUD APPLICATION DEVELOPMENT	L	T	P	J	C
		3	0	2	0	4

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Design and develop elegant and flexible cloud software solutions.
CO2: Manage and deploy a cloud-based application.
CO3: Analyze a real-world problem and develop a cloud-based software solution.
CO4: Evaluate the deployment of web services from cloud architecture.
CO5: Evaluate the security issues related to the development of cloud applications.
CO6: Develop services using cloud computing.

Pre–requisite : Nil

Cos	PROGRAMME OUTCOMES (POs) (S/M/W Indicates Strength of Correlation) S-Strong, M-Medium, W- Weak											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	M	S		M		M					
CO2	S		S		M							
CO3	S		M		M							
CO4	S		M		S							
CO5			M									
CO6			S									

COURSE ASSESSMENT METHODS

DIRECT

1. Continuous Assessment Test I, II (Theory component)
2. Assignment (Theory component)
3. Demonstration etc (as applicable) (Theory component)
4. Pre/Post - Experiment Test/Viva; Experimental Report for each Experiment (lab Component)
5. Model Examination (lab component)
6. End Semester Examination (Theory and lab components)

INDIRECT

1. Course-end survey

INTRODUCTION	7 Hours

Overview – Applications – Intranets and the Cloud – First Movers in the Cloud – Benefits – Limitations – Security Concerns.

CLOUD COMPUTING TECHNOLOGY	8 Hours

Cloud Computing Services: IaaS – PaaS – SaaS – Software Plus Services – Hardware and Infrastructure: Clients – Security – Network – Services – Accessing the cloud : Platforms – Web Applications – Web APIs – Web Browsers.

CLOUD STORAGE AND STANDARDS	7 Hours
Cloud Storage: Overview – Cloud Storage Providers – Standards: Application – Client – Infrastructure – Service.	

DEVELOPING APPLICATIONS	11Hours
Google : Payment – Force.com and Google – Google Gears – Microsoft : Live services – MS SQL Services – MS .NET Services – MS SharePoint Services – Dynamic CRM Services – Design – Development : Amazon Web Services - Google App Engine – Salesforce – MS Windows Azure – SAP HANA- Trouble Shooting – Application Management	

CLOUD DESIGN	5 Hours
Web Application Design – Machine Image Design – Privacy Design – Database Management.	

CLOUD SECURITY	7 Hours
Data Security – Network Security – Host Security – Compromise response.	

Theory: 45	Tutorial: -	Total Hours: 45 Hrs

LIST OF EXPERIMENTS
1. Develop cloud applications using IAAS, PAAS and SAAS. 2. Develop an application using storage services with the help of versioning in cloud. 3. Creating VPC using networking and content delivery services. 4. Develop an application to set up cloud watch to get SNS notifications in Gmail. 5. Develop an application for creating vault in S3 glacier and create user in IAM and storing data in Fastglacier. 6.Develop an application for creating bucket using S3 and create distribution in cloud front to open the website. 7. Create an application for creating role using IAM. 8. Create an application using elastic beanstalk under compute services. 9. Creating a file using elastic file system under storage services. 10. Create a role in IOT device defender under Internet of things.
TotalHours:30 Hrs

1. Toby Velte, Anthony Velte, Robert Elsenpeter, "Cloud Computing: A Practical Approach", McGraw-Hill Education; FirstEdition , 2017.
2. Denys van Kempen, "SAP HANA 2.0: An Introduction ", SAP Press,2019.
3. George Reese, "Cloud Application Architectures", O'Reilly SPD, First Edition, 2011.
4. Buyya R., Broberg J., Goscinski A., "Cloud Computing: Principles and Paradigm", John Wiley& Sons, 2011.

P20CAT3004	ARTIFICIAL INTELLIGENCE	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Know the basics and problem-solving approach to AI problems

CO2: Analyze various search strategies for a problem.

CO3: Evaluate different knowledge representation schemes for typical AI problems.

CO4: Design and implement a typical AI problem to be solved Using Machine Learning
    Techniques.

CO5: Design and implement a futuristic AI application

Cos	PROGRAMME OUTCOMES (POs) (S/M/W Indicates Strength of Correlation) S-Strong, M-Medium, W- Weak											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		S										
CO2		S					M					
CO3		M										
CO4	M	M	S		S					M		
CO5		M	M			M	W			M		

Pre–requisite : Nil

COURSE ASSESSMENT METHODS
DIRECT
1. Continuous Assessment Test I, II
2. Assignment
3. Demonstration etc
4. End Semester Examination
INDIRECT
1. Course-end survey

INTRODUCTION	9 Hours

Introduction – Definition - Future of Artificial Intelligence – Characteristics of Intelligent Agents – Typical Intelligent Agents – AI Applications.

PROBLEM SOLVING METHODS	9 Hours

Problem solving Methods - Search Strategies- Uninformed - Informed - Heuristics – Local Search Algorithms and Optimization Problems - Searching with Partial Observations -Constraint Satisfaction Problems – Constraint Propagation - Backtracking Search – Game Playing -Optimal Decisions in Games -Alpha--Beta Pruning -Stochastic Games.

KNOWLEDGE REPRESENTATION	9 Hours

First Order Predicate Logic – Prolog Programming - Unification -Forward Chaining –Backward Chaining - Resolution –Knowledge Representation - Ontological Engineering - Categories and Objects –Events - Mental Events and Mental Objects - Reasoning Systems for Categories -Reasoning with Default Information

PLANNING AND DECISION MAKING	9 Hours
Probability basics - Bayes Rule and its Applications - Bayesian Networks – Exact and Approximate Inferencein Bayesian Networks - Hidden Markov Models-Learning Decision Trees - Regression and Classification withLinear Models	

MACHINE LEARNING	9 Hours
Forms of Learning -Supervised Learning - Unsupervised Learning - Artificial Neural Networks - Nonparametric Models - Support Vector Machines -Statistical Learning - Learning with Complete Data – Learning with Hidden Variables- Introduction to Expectation Maximization Algorithm – Overview of ReinforcementLearning.	

Theory: 45	Tutorial: -	Total Hours: 45 Hrs

REFERENCES
1. S. Russell and P. Norvig, "Artificial Intelligence: A Modern Approach‖, Prentice Hall, Fourth edition, 2020.
2. Daugherty, Paul R., and H. James Wilson. Human+ machine: Reimagining work in the age of AI. Harvard Business Press, 2018
3. Kaplan, Jerry. Artificial intelligence: What everyone needs to know. Oxford University Press, 2016.

P20CAP3501	MOBILE COMPUTING LAB	L	T	P	J	C
		0	0	4	0	2

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Get an insight into the components and structure of mobile application development
Frameworks for Android and windows OS based mobiles.
CO2: Understand how to work with various mobile application development frameworks.
CO3: Understand the basic and important design concepts and issues of development of mobile
applications.
CO4: Design and Implement various mobile applications using emulators.
CO5: Deploy applications to hand-held devices

Pre–requisite : Nil

Cos	PROGRAMME OUTCOMES (POs) (S/M/W Indicates Strength of Correlation) S-Strong, M-Medium, W- Weak											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	M	M									
CO2	M		M		M							
CO3			M	M	M							
CO4			S	S								
CO5			M									

COURSE ASSESSMENT METHODS

DIRECT

1. Pre/Post - Experiment Test/Viva; Experimental Report for each Experiment (lab Component)
2. Model Examination (lab component)
3. End Semester Examination (lab components)

INDIRECT

1. Course-end survey

LIST OF EXPERIMENTS:

1. Develop an application that uses GUI components, Font and Colours.
2. Develop an application that uses Layout Managers and event listeners.
3. Develop a native calculator application.
4. Write an application that draws basic graphical primitives on the screen.
6. Develop an application that makes use of RSS Feed.
7. Implement an application that implements multi threading.
8. Develop a native application that uses GPS location information.
9. Implement an application that writes data to the SD card.
10. Implement an application that creates an alert upon receiving a message.
11. Write a mobile application that creates alarm clock.

Total Hours: 60 Hrs

ELECTIVES

`

P20CAE0321   **3D MODELING AND GAME DESIGN**

L	T	P	J	C
2	0	0	2	3

COURSE OUTCOMES
After successful completion of this course, the students should be able to
CO1: Understand the foundational knowledge of 3D modeling and apply on a real time   scenario in creating object and environment[K3].
CO2: Design and analyse the usage of Game objects and Assets using Physics and Lights[K4].
CO3: Apply Navigations, Particle systems and audio develop simple games[K3].

Pre–requisite: Nil

COs	CO/PO MAPPING (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak											
	PROGRAMME OUTCOMES (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S		S		S		M					
CO2	M	S	S			M				M		
CO3			M	S		M		W	S	S	S	

THEORY COMPONENT CONTENT
BUILDING BLOCKS   **6 Hours**
 3D space- 3D objects- viewports and cPlane basics- selecting objects- solid object creation- outputting images- Boolean modeling and figured space- object snaps and transforms- Boolean modeling- Clipping plane.

OBJECT AND SURFACE MODELING   **6 Hours**
Profile modeling – surface- cPlane- revolve- object modeling- project and pull- curves from objects- trimming surfaces- surface modeling – lofting- surface filleting and blending- surface from edge curves- patch surfaces.

GAME OBJECTS AND ASSETS   **6 Hours**
Native Game Objects -Manipulating Game Objects - Components in the Game engine – Fundamentals working concept - Materials-   Defining the Role of the Prefab - Textures: UV Mapping and Texturing Techniques - Discovering the Standard Shader.

IMPLEMENTATION OF ASSETS WITH PHYSICS AND LIGHTING   **6 Hours**
Creating Hierarchies - Using Empty Game Objects as Pivots -Understanding the Physics System – Rigid body Components - Colliders - Scripting Collision Events - Lighting in Games-Analyzing the Different Lights and Properties.

NAVIGATION AND ANIMATIONS   **6 Hours**
Animation in Game Development - Creating Animation in the Editor-Refining Animation- NavMesh - NavMesh Agent - NavMesh Obstacle-Creating the Player Controller Game Object- Particles in Video Games-Analyzing Existing Particle Effects-Audio in Game Development -Audio Effects.

REFERENCES
1. "The Ultimate Guide to Game Development with Unity" by Unity Technologies,2023.

`

2. The Art of Game Design: A Book Of Lenses, THIRD EDITION, Jesse Schell, CRC Press; 3rd edition , 2019.
3. Paris Buttfield-Addison, Jon Manning, Tim Nugent, "Unity Game Development Cookbook", O'Reilly Media, Inc. 2019.
4. 3D Modeling for Beginners: Learn Everything You Need to Know About 3d Modeling!, Danan Thilakanathan,2016.

ONLINE LEARNING MATERIALS
1. https://www.coursera.org/learn/introduction-to-3d-modeling
2. https://www.coursera.org/specializations/game-design-and-development
3. https://www.coursera.org/learn/game-design
4. Control physics with C# in Unity (coursera.org)
5. Create basic behavior with C# in Unity (coursera.org)
6. The Complete Guide to 3D Modeling with Blender | Udemy

PROJECT:

Projects involving3D modeling using Blender and design simple games with effective audio, light, animation and appropriate understanding of physics in Real time environment.

Theory: 30	Tutorial: 0	Practical: 0	Project: 30	Total: 60 Hours

`

**P20CAE0322   AUGMENTED REALITY AND VIRTUAL REALITY APPLICATION
                DEVELOPMENT**

L	T	P	J	C
2	0	0	2	3

COURSE OUTCOMES
After successful completion of this course, the students should be able to

CO1: Attain a foundational understanding and difference of Augmented and Virtual reality technologies[K3].

CO2: Develop skills in placing assets, managing scale, addressing occlusion, and implementing realistic lighting in AR and VR projects. [K6]

CO3: Apply AR and VR in practical scenarios and conducting AR/VR based visualization case studies for product development. [K3]

Pre–requisite: P20CAE0321 - 3D Modeling and Game Design

COs	CO/PO MAPPING (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak											
	PROGRAMME OUTCOMES (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S		M		S		M					
CO2	M	M	S	S		M				M		
CO3			S	S		M		W	S	S	S	

THEORY COMPONENT CONTENT

AUGMENTED AND VIRTUAL REALITY BASICS   8 Hours
Introduction to Augmented Reality -MAR Market, Actors, and Value Chain - Application vs. Browser -MAR System Architecture- Difference between AR and VR, Challenges with AR, AR systems and functionality, Augmented reality methods, visualization techniques for augmented reality, enhancing interactivity in AR environments, evaluating AR systems.

Virtual Reality and Virtual Environment: Introduction, Computer graphics, Real time computer graphics, Flight Simulation, Virtual environment requirement, benefits of virtual reality, Historical development of VR, Scientific Landmark.

AR AND VR TECHNOLOGIES   8 Hours
Placing and positioning assets - Scale and size of assets - Occlusion -Lighting for increased realism - Solid augmented assets – context awareness - tracking in AR - outside-in tracking - motion tracking - environmental understanding - feature points - plane finding – light estimation - anchors - interface issues and lack of UI metaphors -technical constraints – 3D barriers - computer vision limitations - constraints of occlusion and shading.

Levels of Immersion in VR Systems - Sensorimotor Contingency -Sensorimotor Contingency in VR - Introduction to the Three Illusions: Place Illusion (PI), Plausibility Illusion (Psi) - Necessary Conditions for Psi - Break of Presence - Presence, Immersion, PI, and Psi - The Pinocchio Illusion - The Rubber Hand Illusion - Psychological Effects of Embodiment Illusion - Visual-Tactile and Visual-Motor Synchrony.

AR CORE   7 Hours
Android OS - limitations of low light conditions on AR on mobile -simple surfaces challenge AR – user flow - working with tech limitations - preparing your tools - design draft. surface detection and creating plane - user interaction - placing with anchor points - occlusion between virtual assets - light estimation - virtual light to real light - multiplane detection and spatial mapping - processing

`

needs in mobile AR - breaking immersion - framing as a creative device.

VR SYSTEMS AND HARDWARES   **7 Hours**
The Virtual world space-positioning the virtual observer- perspective projection, human vision, stereo perspective projection, 3D clipping, Colour theory. Illumination models- Reflection models- Shading algorithms, Radiosity, Hidden Surface Removal- Realism -Stereographic image. VR Hardware- sensor hardware, Head-coupled displays, Acoustic hardware.

REFERENCES
1. Linowes, J., & Babilinski, K. (2017). Augmented Reality for Developers: Build Practical Augmented Reality Applications with Unity, ARCore, ARKit, and Vuforia. Packt Publishing Ltd.
2. XR Development with Unity-A beginner's guide to creating virtual, augmented, and mixed reality experiences using Unity by Anna Braun, Raffael Rizzo(2022).
3. Mastering Augmented Reality: A Comprehensive Guide to Learn Augmented Reality by Cybellium Ltd, Kris Hermans (2023)
4. Peddie, J. (2017). Augmented Reality: where we will all live. Springer.
5. Ong, S. (2017). Beginning windows mixed reality programming. Berkeley, CA: Apress. Doi, 10, 978-1.
6. "The VR Book: Human-Centered Design for Virtual Reality (ACM Books)"by Jason Jerald (2015).

ONLINE LEARNING MATERIALS
1. https://www.coursera.org/learn/ar |Coursera
2. https://www.coursera.org/professional-certificates/meta-ar-developer |Coursera
3. https://www.coursera.org/specializations/extended-reality-for-everybody|Coursera
4. https://www.coursera.org/specializations/virtual-reality
5. https://www.coursera.org/learn/introduction-virtual-reality
6. https://www.coursera.org/learn/making-virtual-reality-game
7. https://www.coursera.org/learn/3d-models-virtual-reality
8. https://www.coursera.org/learn/intro-augmented-virtual-mixed-extended-reality-technologies-applications-issues

PROJECT   **30 Hours**
To Design and Integration of 3D Spatial audio and sound effects to the objects developed and exploring creative possibilities with AR Core, implement AR/VR navigation system (UX), AR/VR interaction system (UX), Applying AR/VR technologies in real time applications.

| Theory: 30 | Tutorial: 0 | Practical: 0 | Project: 30 | Total: 60 Hours |

`

P20CAE0023   ADVANCED METAVERSE TECHNOLOGIES

L	T	P	J	C
3	0	0	0	3

COURSE OUTCOMES
After successful completion of this course, the students should be able to
CO1: Acquire knowledge to differentiate various Extended reality technologies in Metaverse.
CO2: Apply Metaverse Experiences with depth understanding on devices and interoperability.
CO3: Analyze Metaverse in various application domains.
CO4: Develop the Metaverse environment with the integration of other technologies.

Pre–requisite: NIL

COs	CO/PO MAPPING (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak											
	PROGRAMME OUTCOMES (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S		M				M					
CO2	M	M	S	S		M	S			M		
CO3		S	S	M	S					M		
CO4	S		S			M		W	S	S	S	

THEORY COMPONENT CONTENT

THE FOUNDATION OF XR & METAVERSE   **7 Hours**
The Brain Science behind VR - Understanding Augmented Reality (AR), Virtual Reality (VR), Mixed Reality (MR), Web XR - Differences & Similarities of VR/AR/MR-XR in Metaverse.

EXPERIENCE WITH METAVERSE   **8 Hours**
Metaverse-Experiences in metaverse-Avatars in metaverse-Interoperability in the metaverse-connections and communications-Devices to access the metaverse.

APPLICATIONS OF METAVERSE   **8 Hours**
Educational potential in metaverse-Learning in the metaverse-Health and architecture in metaverse-Arts, entertainment, and sports in the metaverse-Building a safe metaverse.

TECHNOLOGIES IN METAVERSE   **11 Hours**
Web 3.0-Artificial Intelligence (AI) in Metaverse- Cyber Security aspects / How safe is Metaverse - Blockchain, NFT (non-fungible token) and crypto currency -Metaverse and NFTs - Metaverse Use Cases - Top Metaverse platforms - Current Challenges in Mass adoption of XR - Impact of 5G in XR - Role of Microsoft, Apple and Facebook in Metaverse

INTERACTING IN METAVERSE   **11 Hours**
On-premise/Local hosting - Cloud Hosting & Streaming services - Distribution via Application Stores - Understanding UI & UX Design Essentials for AR/VR - Types of Navigation - Types of interaction (Understanding Hand controllers, gesture, gaze and voice controls) - Avatar implementations in VR (Torso/Full body) - AR/VR/Metaverse 3D Assets creation Tools Overview - 3D assets creation for VR/AR (Native polygonal modeling, Converting CAD models, 3D Scanning, Photogrammetry)

Theory:45	Tutorial:0	Practical:0	Project:0	Total: 45 Hours

REFERENCES

`

1. "The Metaverse: And How it Will Revolutionize Everything" by Matthew Ball. published in 2022.
2. Metaverse for Beginners: The Ultimate Guide to Understanding and Investing in Web 3.0, NFTs, Crypto Gaming, and Virtual Reality by Donn Newman in 2022
3. The Fourth Transformation: How Augmented Reality & Artificial Intelligence Will Change Everything by Robert Scoble, Shel Israel published in 2016

ONLINE LEARNING MATERIALS
1. https://www.coursera.org/learn/what-is-the-metaverse| Coursera
2. Metaverse Web 3.0 and DeFi: A Fintech Masterclass| Udemy

`

P20CAE0224	EMBEDDED SYSTEMS FOR IOT	L	T	P	J	C
		2	0	2	0	3

COURSE OUTCOMES

After successful completion of this course, the students should be able to

CO1: Identify the internal architecture and programming of an embedded processor. [K3]
CO2: Utilize the basic architecture of Internet of Things based Devices [K3]
CO3: Make use of hardware platforms and AI Enabled Boards for application development.[K3]
CO4: Choose the software platforms to process the IoT Data.[K3]
CO5: Build an embedded and IoT Solution for real world scenarios[K5]

Pre-requisite : NIL

COs	CO/PO MAPPING (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak											
	PROGRAMME OUTCOMES (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	S		S	M							
CO2	S		S									
CO3	S	M	M	M								
CO4	S		S		S	M			M	M		
CO5	S	S		M	M					S	M	

THEORY COMPONENT CONTENT

EMBEDDED AND MICROCONTROLLER CONCEPTS **7 Hours**

Introduction to embedded processors-Categories of embedded processors-Architecture-Introduction to PIC microcontrollers, architecture and memory organization, registers, I/O ports, interrupts, timer, instruction sets, Embedded Communication Protocols – UART, USART,I2C, SPI, Modbus-Introduction to Real-Time Operating Systems (RTOS)- RTOS Architecture: Layered Architecture of an RTOS -Kernel Components and Their Functions-Real-Time Operating System Services

INTERNET OF THINGS **5 Hours**

Introduction to Internet of Things (IoT), Functional Characteristics, IoT building blocks - Architecture and working - Elements of an IoT ecosystem-IOT Application Development Cycle-Technology drivers, Business drivers, Trends and implications -Recent Trends in the Adoption of IoT, Role of cloud in IoT. IoT Enabling Technologies

HARDWARE PLATFORMS FOR IOT **6 Hours**

Development Boards -Arduino, Raspberry Pi, ESP8266, AI Enabled Boards (Jetson Boards for IoT development), Sensors and actuators -Types-Functions, and applications: Gateways- connectivity options for Short range/Long range Communication- IoT device communication protocols Overview.

SOFTWARE DEVELOPMENT FOR IOT **6 Hours**

IDEs for IoT prototyping- Arduino Programming - Arduino functions- Interfacing with sensors and actuators-Libraries -Input/Output From Pins - Raspberry Pi platform -Environmental -Programming and interfacing with basic hardware components. Open Platforms-Platforms Overview- IBM Watson IoT—Bluemix, Eclipse IoT, AWS IoT, Microsoft Azure IoT Suite, Google Cloud IoT

`

APPLICATION DEVELOPMENT **6 Hours**
Development of IoT Applications - Cloud platforms for IoT, Cloud data logging and monitoring, Interfacing with web services.
IOT Prototyping - Home Automation –Smart Agriculture – Smart Cities – Smart Healthcare.

LAB CONTENTS: **30 Hours**
To understand the IoT tools and Platforms. Build a basic home automation system. IoT solution for agriculture, IoT-based smart parking system, Smart Cities - Smart Waste Management, Smart Street Lights, Healthcare - Baby Monitoring.

Sample Experiment:

1. Embedded C Programming and Interfacing with various peripherals
2. Integration of Actuators with node MCU (Servo motor/Relay).
3. Capture Image with node MCU.
4. Explore different communication methods with IoT devices (Zigbee, GSM, Bluetooth).
5. Make use of cloud platform to log the data.
6. Build a basic home automation system using IoT devices.
7. Develop an IoT solution for agriculture.
8. Design an IoT-based smart parking system.

REFERENCES:
1. Perry Xiao, Designing Embedded Systems and the Internet of Things (IoT) with the ARM mbed, 1119363993, Wiley, First Edition, 2018.
2. Robert Barton, Patrick Grossetete, David Hanes, Jerome Henry, Gonzalo Salgueiro, "IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things", CISCO Press, 2017.
3. Raj Kamal, " Internet of Things: Architecture and Design", McGraw Hill.2nd edition June 2022.
4. Arduino Programming in 24 hours, Richard Blum, 1st Edition, ISBN: 978-0672337123, Sams Tech Yourself Publishing.2014
5. Adrian Mcewen, Hakin Cassimally, "Designing the Internet of Things", First Edition, Wiley, 2014

ONLINE COURSES:
1. https://onlinecourses.nptel.ac.in/noc22_cs53/preview
2. https://www.coursera.org/learn/iot-wireless-cloud-computing
3. https://www.udemy.com/course/complete-guide-to-build-iot-things-from-scratch-to-market/

Theory:30	Tutorial:0	Practical:30	Project:0	Total: 60 Hours

`

P20CAE0325   **IOT SYSTEMS DESIGN**

COURSE OUTCOMES
After successful completion of this course, the students should be able to
- **CO1:** Choose relevant IoT reference architecture for providing a standardized framework for design and implementation of solutions. [K3]
- **CO2:** Design and implement IoT systems by selecting appropriate communication protocols to enable seamless data exchange between devices [K3]
- **CO3:** Demonstrate proficiency in managing and processing IoT data for real time scenarios. [K3]
- **CO4:** Articulate the issues and challenges involved in integration of large scale IoT system. [K3].

Pre-requisite: NIL

COs	CO/PO MAPPING (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak											
	PROGRAMME OUTCOMES (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	S										
CO2	S	S										
CO3		S	S		M		M		M			M
CO4		S	S		M		M		M			M

THEORY COMPONENT CONTENTS

IOT ARCHITECTURE   **6 Hours**
Types of IOT Architecture - Three-Tier IoT Architecture, Five-Tier IoT Architecture, Hierarchical IoT Architecture - Mesh IoT Architecture, Microservices IoT Architecture, Serverless IoT Architecture

IOT PROTOCOLS   **6 Hours**
Application Layer Protocols-MQTT , CoAP , HTTP , AMQP . Network Layer Protocol- IPv6, 6LoWPAN, RPL. Data Link Layer Protocols-ZigBee, BLE. Physical Layer Technologies-RFID-LoRa

DATA MANAGEMENT AND PROCESSING   **6 Hours**
Data Management -Data Ingestion-Edge and Fog Computing in Large-Scale IoT-Big Data Technologies for IoT-IoT Analytics

INTEGRATION AND STANDARDS   **6 Hours**
IoT Network Topologies- Scalability, reliability, and latency requirements-IoT Middleware-Interoperability and Standards -API Design for IoT Integration -Case Studies and Industry Practices

INTEGRATING LARGE-SCALE IOT SYSTEMS   **6 Hours**
Overview of Large-Scale IoT Systems-Challenges and Opportunities, Architectural Considerations-Scalable IoT Architectures-Distributed Systems and Microservices- IoT Security- Case Studies-Use cases in Industrial IoT.

PROJECT COMPONENT: **30 Hours**
Design and develop prototypes by applying suitable architecture models and protocols in scenarios like cloud-based smart facility management, healthcare, environment monitoring systems, etc.

`

| Theory:30 | Tutorial:0 | Practical:0 | Project:30 | Total: 60 Hours |

REFERENCES :
1. Cirani, S., Ferrari, G., Picone, M., & Veltri, L., "Internet of Things Architectures, Protocols and Standards", Wiley, 2018.
2. Höller, J., Tsiatsis, V., Mulligan, C., Karnouskos, S., Avesand, S., & Boyle, D., " From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence", Springer, 2019.
3. Gravina, R. (Ed.), Palau, C. E. (Ed.), Manso, M. (Ed.), Liotta, A. (Ed.), Fortino, G. (Ed.), "Integration, Interconnection, and Interoperability of IoT Systems (Internet of Things)", Springer, 2018.
4. Hanes, D., Salgueiro, G., Grossetete, P., Barton, R., Henry, J., "IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things", Cisco Press,2017.

ONLINE COURSES :
1. https://www.coursera.org/programs/coursera-for-campus-faculty-ovg1y/learn/m2m-iot-interface-design-embedded-systems?source=search
2. https://www.coursera.org/programs/coursera-for-campus-faculty-ovg1y/learn/iot-networking?source=search
3. https://www.coursera.org/programs/coursera-for-campus-faculty-ovg1y/learn/iot-systems-and-industrial-automation-course-1?source=search
4. https://www.coursera.org/learn/advanced-iot-systems-and-industrial-applications-course-3
5. https://onlinecourses.nptel.ac.in/noc22_cs53/preview

`

P20CAE0226	IOT APPLICATION DEVELOPMENT	L	T	P	J	C
		2	0	2	0	3

COURSE OUTCOMES
After successful completion of this course, the students should be able to
  CO1: Apply the concept of IoT for application development [K3]
  CO2: Build context-aware and gestural interfaces for IoT applications[K3]
  CO3: Construct prototype using wireframes for different device interfaces[K3]
  CO4: Make use of different testing strategies for IoT applications[K3]
  CO5: Develop an appropriate deployment architecture for an IoT project[K3]

Pre-requisite: P20CAE0224 - Embedded systems for IoT

COs	CO/PO MAPPING (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak											
	PROGRAMME OUTCOMES (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S		M		S							
CO2	S		M									
CO3	S	S			M						M	
CO4	S			S		M						
CO5	S		S							S		

THEORY COMPONENT CONTENTS

INTRODUCTION   5 Hours
Overview of IOT Application Development - UI/UX Considerations -Feasibility Study- Architecture
and Design- **User Interface for Device Management** - Testing and Quality Assurance-
Deployment- Monitoring and Optimization- End-of-Life Planning.

USER INTERFACE DESIGN   7 Hours
User-centered design principles- Device Control Interfaces- Multi-Device Interaction - Responsive
Design for Various Screens -Navigation design- Voice and Natural Language Interfaces-Grid
systems and layout-Typography in UI design-Color theory and its application-Creating effective user
flows- Error Handling and Feedback- Context-Aware Interfaces- Gestural Interfaces.

PROTOTYPING AND WIRE FRAMING   6 Hours
Prototyping tools-Types of Prototypes- key elements of wireframes-creating basic wireframes-
Device Interface Prototyping- Sensor Data Visualization- Interaction Flows- Mobile and Web
Application Wire framing- Voice and Gesture Interaction Prototypes- Edge Computing Integration-
Error Handling and Feedback Prototypes- Remote Monitoring Interfaces.

IOT TESTING   6 Hours
Challenges -Unit Testing for IoT Components- Integration Testing for IoT Device -Security Testing
for IoT Devices and networks- End to End Testing - Automation Framework and Tools -Metrics of
Performance testing- Device and Power Management

APPLICATION DEPLOYMENT   6 Hours
IoT Deployment Strategies and Project Planning-Deployment Considerations- Challenges and Risks
-Deployment Architecture-Configure and set up edge devices - Cloud Platform - Connectivity and

`

Communication-Data Handling and Storage-Deployment Testing-Monitoring and Management.

LAB COMPONENT

Create a real-time IoT application by integrating UI/UX design tools (Sketch, Figma). Utilize wireframing techniques to prototype and visualize the IoT application's layout and operations. Deploy the IoT project to make it operational and accessible by users.

Sample Experiments:
1. Set up a basic IoT ecosystem with microcontrollers and sensors.
2. Simulate a small-scale smart factory using IoT devices
3. Develop prototypes for Smart City applications such as Smart Street Lights or Smart Waste Management.
4. Design a user interface that adjusts to various screen sizes.
5. Implement responsive design using CSS and HTML
6. Use tools like InVision or Marvel to create interactive prototypes for an IoT application
7. Design wireframes for the user interfaces of specific IoT applications (e.g., Smart Home Control).

Theory:45	Tutorial:0	Practical:30	Project:0	Total: 60 Hours

REFERENCES

1. "Building the Internet of Things: Implement New Business Models, Disrupt Competitors, Transform Your Industry" by Maciej Kranz, ISBN: 978-1-119-28568-7, 2016.
2. "Prototyping: A Practitioner's Guide" by Todd Zaki Warfel,2009.
3. Designing in Figma: The Complete Guide to Designing with Reusable Components and Styles in Figma , Eugene Fedorenko, 2020
4. "Designing Connected Products: UX for the Consumer Internet of Things" by Claire Rowland, Elizabeth Goodman, Martin Charlier, and Ann Light, 2015
5. "IOT Deployment Handbook: A practical Guide to Implementing Successful IOT Projects" By Richard G. Brown, 2022

Online Course Links:
1. https://www.coursera.org/programs/coursera-for-campus-faculty-vg1y/learn/iot?source=search
2. https://www.coursera.org/programs/coursera-for-campus-faculty-ovg1y/specializations/interaction-design?source=search
3. https://www.udacity.com/course/ux-design-for-mobile-developers--ud849
4. https://www.coursera.org/programs/coursera-for-campus-faculty-ovg1y/learn/prototyping-design?source=search
5. https://www.coursera.org/programs/coursera-for-campus-faculty-ovg1y/learn/iot-systems-and-industrial-automation-course-1?source=search
6. https://www.udemy.com/course/master-the-secrets-of-figma-a-complete-beginners-course/

`

P20CAE0227   3D PRINTING

L	T	P	J	C
2	0	2	0	3

COURSE OUTCOMES

After successful completion of this course, the students should be able to

CO1: Make use of 3D printing technologies and realize the applications[K3]

CO2: Identify 3D printing process chain in additive manufacturing.[K3].

CO3: Develop proficiency in using 3D modelling software.[K3]

CO4: Identify various issues involves in common 3D printing techniques [K3]

CO5: Apply the concepts of advanced 3D printing techniques to develop applications [K3]

Pre-requisite: Nil

COs	CO/PO MAPPING (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak											
	PROGRAMME OUTCOMES (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S				M							
CO2		S			M		M					M
CO3		M			M		M					M
CO4	S				M				M			
CO5	S	M			M				M			

THEORY COMPONENT CONTENTS

INTRODUCTION TO 3D PRINTING   5 Hours

Overview of 3D Printing technology - Historical background and advancements - Applications and real-world examples - Additive manufacturing techniques - Fused Deposition Modeling (FDM) - Stereolithography (SLA) - Digital Light Processing (DLP) -Selective Laser Sintering (SLS) - Direct Metal Laser Sintering (DMLS) - Other Types (MSLA, BJP, EBM, LOM) - Variations of FDM 3D Printing Machines

3D PRINTING PROCESS CHAIN & PHOTOPOLYMERIZATION PROCESSES   7 Hours

Steps in Additive manufacturing - Design for 3D printing - Software in 3D Printing - Materials for 3D Printing - Post-processing and finishing techniques; Introduction to Photopolymerization Processes - Photopolymerization Materials - Reaction Rates - Vector Scan SL - SL Resin Curing Process - SL Scan Patterns - Vector Scan Micro Stereolithography - Mask Projection Photopolymerization Technologies and Processes - Two-Photon SL

3D DESIGNING   6 Hours

Introduction to 3D modeling software - Creating 3D Models - Designing basic geometric shapes - CAD software and tools - Parametric modeling - Creating complex structures and assemblies; Preparing Models for 3D Printing - Design considerations for 3D printing - Mesh repair and optimization - File formats for 3D printing - Slicing software and its features - Layer height and resolution settings - Support structures; Print bed adhesion techniques – Orientation – Rafts.

TROUBLESHOOTING AND CALIBRATION   6 Hours

Components of FDM & Stereolithography printers - Identifying and resolving common print issues - Adjusting print settings for optimal results- Materials Handling Issues - Hardware & Software Calibrations.

`

ADVANCED 3D PRINTING TECHNIQUES 6 Hours

Multi-Material Unit (MMU) and Multi-Color Printing - Overview of 3D scanning technologies - Point cloud data and mesh generation - Reverse engineering and modification of existing models - High-resolution printing - Large-scale printing - Applications - Industrial applications - Medical and healthcare applications - Automotive and aerospace industries - Art, Architecture, Fashion & Food - Education and prototyping.

LAB CONTENTS: 30 Hours

This lab component focuses on teaching students the fundamentals of 3D printing and design, using various printing techniques, materials, and post-processing methods. Students will engage in hands-on experiments to understand the complete process of 3D printing, from design to troubleshooting.

Sample Experiments:
1. 3D Modeling with Basic Shapes: Introduction to 3D modeling software and creation of basic geometric shapes.
2. FDM Printing Basics and SLA Comparison: Use an FDM printer for a simple model, then print the same model with an SLA printer for comparison.
3. Calibrating and Optimizing 3D Printers: Learn to calibrate FDM printers, including bed leveling and extruder settings. Also, cover basic SLA printer settings.
4. Model Correction and Preparation: Identify and correct common 3D model issues, preparing the model for efficient printing.
5. Orientation and Support Structure Analysis: Experiment with model orientations and support structures for both FDM and SLA printing.
6. Choosing the Best Printing Method: Analyze a 3D model to determine the most suitable printing method, considering the model's geometry and application.
7. Post-Processing Techniques: Learn post-processing techniques for both FDM (like sanding and painting) and SLA prints (including resin curing and support removal).
8. Troubleshooting 3D Printers: Identify and resolve common issues in both FDM and SLA printing.
9. Material Analysis and Application: Study different printing materials for FDM and SLA, understanding their properties, strengths, and use cases.
10. Efficiency and Precision in 3D Printing: Focus on recreating a provided 3D model with precision and optimizing print settings for efficiency within a time limit.

Theory: 45	Tutorial: 0	Practical: 0	Project: 0	Total: 45 Hours

REFERENCES

1. "Mastering 3D Printing :A Guide to Modeling, Printing and Prototyping" by Joan Horvath, Rich Camerona, published in May 2020.
2. 3D Printing Failures: How to Diagnose and Repair ALL Desktop 3D Printing Issues" by Sean Aranda and David Feeney published in January 2020.
3. "Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing by Ian Gibson, David W Rosen, Brent Stucker published in 2010.
4. "Rapid Prototyping: Principles & Applications" by Chua Chee Kai, Leong Kah Fai published in January 2010.

`

ONLINE COURSES

1. https://www.coursera.org/specializations/rapid-prototyping-using-3d-printing
2. https://www.coursera.org/learn/3d-printing-applications#modules.
3. https://www.coursera.org/specializations/3d-printing-additive-manufacturing
4. https://www.udemy.com/course/3d-printing-for-beginners/
5. https://www.udemy.com/course/3d-printing-from-start-to-finish/
6. https://www.udemy.com/course/learn-3d-printing/

`

P20CAE0228 **ROBOTIC OPERATING SYSTEMS**

L	T	P	J	C
2	0	2	0	3

COURSE OUTCOMES
After successful completion of this course, the students should be able to
CO1: Apply the concepts of ROS to enable the development of robotic system [K3]
CO2: Implement ROS topics and messages for efficient data transfer between nodes. [K3]
CO3: Utilize ROS visualization tools, such as RViz, to analyze and debug ROS applications. [K3]
CO4: Develop ROS perception packages for object detection, recognition, and tracking.[K3]
CO5: Apply ROS drivers for tasks such as sensor data acquisition, robot navigation, and object manipulation [K3]

Pre-requisite: P20CAT1103 -Advanced Operating Systems

COs	CO/PO MAPPING (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak											
	PROGRAMME OUTCOMES (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S				M							
CO2		S			M							
CO3					S							
CO4		S			M							
CO5	S				M							

THEORY COMPONENT CONTENT

INTRODUCTION **6 Hours**
Introduction to ROS-Installation of ROS on different platforms-ROS basic concepts-Components: Nodes, topics, messages, and services- ROS communication architecture-ROS Packages and Ecosystem

ROS TOOLS AND ENVIRONMENT **6 Hours**
ROS Tools and Environment- command-line tools- ROSIDEs- ROS Integrated Development Environments (IDEs)- graphical tools for visualization and debugging- Rviz, Rqt, and Gazebo-Creating and managing ROS workspaces-Version control with ROS

ROS COMMUNICATION **6 Hours**
ROS nodes and communication - ROS Topics - Publishing and subscribing to topics-Working with ROS topics and messages-ROS services and parameters-ROS launch files for managing multiple nodes-ROS Middleware-ROS Libraries

ADVANCED ROS TOPICS **7 Hours**
Perception in ROS- Perception libraries (OpenCV, PCL)- Integration of sensors: Cameras, Lidar, IMU - Basic computer vision techniques in ROS Robot Navigation and Control
- ROS navigation stack-Path planning algorithms-Simulating and executing robot navigation- ROS control stack

ROS AND ROBOT DRIVERS **5 Hours**
ROS and Robot Drivers-Writing drivers to interface hardware with ROS-Interfacing Sensors and Actuators-Connecting sensors and actuators to the ROS ecosystem-Integration with Robot

`

Platforms- Working with popular robot platforms.

LAB COMPONENT :
Create a simple ROS package with a publisher and a subscriber node-Extend the package to include a service, Expand the package to include an action server that moves a robot forward for a specified duration- Computer Vision with ROS- Integration with Hardware -Use RViz to visualize the movement of a robot as it receives commands from the publisher.

Sample Experiments:
1. Installation and Create a ROS workspace.
2. Create and run a simple ROS node-Publish and subscribe to ROS topics.
3. ROS Tools-Use Rviz for visualization.-Experiment with Rqt tools.
   a. Working with Launch Files:-Create a launch file to start multiple nodes-Pass parameters through launch files.
4. Design a simple robot using URDF
   a. Simulate the robot in Gazebo
   b. ROS Services and Actions:
5. Implement a simple ROS service
   a. Create and use a ROS action server.
   b. Navigation in ROS
   c. Set up the ROS Navigation Stack
   d. Implement basic path planning
6. Computer Vision with ROS
   a. Use OpenCV with ROS for image processing.
7. Integration with Hardware:
   a. Interface with a real-world sensor (e.g., Lidar or IMU) using ROS.
   b. Control actuators or motors using ROS commands.

Theory: 30	Tutorial: 0	Practical: 30	Project: 0	Total: 60 Hours

REFERENCES

1. Programming Robots with ROS: A Practical Introduction to the Robot Operating System, O'Reilly Media; by Morgan Quigley, Brian Gerkey, William D. Smart ,1st edition, 2015.
2. Robot Operating System (ROS): The Complete Beginner's Guide" - Morgan Quigley, Apress; 1st edition , 2018.
3. Robot Operating System (ROS) for Absolute Beginners: Robotics Programming Made Easy, Lentin Joseph, Apress, 1st edition ,2018.
4. ROS Robotics By Example, Carol Fairchild , Dr. Thomas L. Harman, Packt Publishing Limited, 2016.

ONLINE COURSES:
1. https://www.edx.org/learn/robotics/delft-university-of-technology-hello-real-world-with-ros-robot-operating-system
2. https://www.udemy.com/course/ros-essentials/
3. https://www.udemy.com/course/self-driving-and-ros-learn-by-doing-odometry-control/
4. https://www.udemy.com/course/ros-for-beginners/
5. https://www.coursera.org/learn/intro-self-driving-cars?specialization=self-driving-cars

`

		L	T	P	J	C
P20CAE0029	**SOFTWARE DEFINED VEHICLE**	3	0	0	0	3

COURSE OUTCOMES
After successful completion of this course, the students should be able to

CO1: Identify the Software Defined Vehicle concepts and realize the paradigm shift from hardware to software centric vehicle design [K3]

CO2: Make use of core principles of SDV architecture, including the separation of hardware and software and the layered software stacks [K3]

CO3: Utilize the Model-Based Development (MBD) and AUTOSAR Standard for automotive software development [K3]

CO4: Apply the key technologies in Self-Driving Vehicles to create a robust and reliable autonomous system [K3]

Pre-requisite: Nil

COs	CO/PO MAPPING (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak											
	PROGRAMME OUTCOMES (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	S										
CO2	S	S										
CO3			S		M	M	M					M
CO4			S		M	M	M					M

THEORY COMPONENT CONTENT
INTRODUCTION   9 Hours
Overview of software-defined vehicles - Historical perspective and evolution - Essential system basics - Support processes for electronic systems and software development.

IN-VEHICLE SOFTWARE ARCHITECTURE   9 Hours
Software architectures - ECUs (Electronic Control Units) and their functions - Bus systems – CAN: Concepts, Components, Applications – LIN: Concept, Components - Event Triggered and Time Triggered Protocol - TTCAN - FlexRay - Evaluation of Automotive Software Architectures.

AUTOMOTIVE SOFTWARE DEVELOPMENT   9 Hours
Software development life cycle - Automotive Software Development - Core process for electronic systems and software engineering - Methods and tools for development - Model-Based Development (MBD) and AUTOSAR Standard - Detailed Design of Automotive Software.

CONNECTED VEHICLES   9 Hours
Vehicle-to-Vehicle (V2V) and Vehicle-to-Infrastructure (V2I) communication - Vehicle-to-Everything (V2X) communication - Wireless Communication Technologies (DSRC, LTE, 5G) - Functional Safety of Automotive Software.

SDV ENABLING TECHNOLOGIES   9 Hours
Levels of automation - Sensor technologies (LiDAR, RADAR, cameras) – Perception, Localization, Mapping, Decision Making, Planning and Control Systems - Over-the-Air (OTA) Updates - Regulatory Compliance.

`

REFERENCES:

1. Jörg Schäuffele (Author), Thomas Zurawka,"Automotive Software Engineering: Principles, Processes, Methods, and Tools", Society of Automotive Engineers, 2016
2. Miroslaw Staron, "Automotive Software Architectures An Introduction", Springer, 2017.
3. Colt Correa, John Simon, Martin Gubow, Samir Bhagwat, "Automotive Ethernet: The Definitive Guide", Intrepid Control Systems, 2nd edition, 2023.
4. Marco Di Natale, Haibo Zeng, Paolo Giusto, Arkadeb Ghosal, "Understanding and Using the Controller Area Network Communication Protocol Theory and Practice", Springer New York, NY,2012.
5. Navet, Nicolas, and Françoise Simonot-Lion, eds. "Automotive embedded systems handbook". CRC press, 2017.
6. Paret, Dominique. "Multiplexed networks for embedded systems: CAN, LIN, flexray, safe-by-wire.", John Wiley & Sons, 2007.

ONLINE RESOURCES:

1. https://www.coursera.org/learn/intro-self-driving-cars

`

P20CAE0230   ETHICAL HACKING AND NETWORK DEFENCE

L	T	P	J	C
2	0	2	0	3

COURSE OUTCOMES

After successful completion of this course, the students should be able to

CO1: Illustrate the legal and ethical requirements related to ethical hacking (K3)

CO2: Interpret the vulnerabilities, mechanisms to identify vulnerabilities, threats, attacks (K3)

CO3: Perform penetration & security testing to identify the vulnerabilities in the application (K4)

CO4: Examine the different tools and techniques that ethical hackers employ (K4)

Pre-requisite: Nil

COs	CO/PO MAPPING (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak											
	PROGRAMME OUTCOMES (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	M										
CO2	S	M			M					M		
CO3	S	M			M	M				M		M
CO4	S	M			M							M

THEORY COMPONENT CONTENT

ETHICAL HACKING OVERVIEW & VULNERABILITIES   6 Hours

Understanding the importance of security, Concept of ethical hacking and essential Terminologies-Threat, Attack, Vulnerabilities, Target of Evaluation, Exploit. Phases involved in hacking.

FOOTPRINTING & PORT SCANNING   6 Hours

Footprinting - Introduction to foot printing, Understanding the information gathering methodology of the hackers, tools used for the reconnaissance phase. Port Scanning - Introduction, using port scanning tools, ping sweeps, Scripting enumeration-Introduction, enumerating windows OS & Linux OS

SYSTEM HACKING   6 Hours

Aspect of remote password guessing, Role of eavesdropping, Various methods of password cracking, Keystroke Loggers, Understanding Sniffers, Comprehending Active and Passive Sniffing, ARP Spoofing and Redirection, DNS and IP Sniffing, HTTPS Sniffing. Side-channel Attacks on Cryptographic Hardware: Basic Idea, Current-measurement based Side-channel Attacks. Hardware Trojans: Hardware Trojan Nomenclature and Operating Modes, Countermeasures Such as Design and Manufacturing Techniques to Prevent/Detect Hardware Trojans.

HACKING WEB SERVICES & SESSION HIJACKING   6 Hours

Web application vulnerabilities, application coding errors, SQL injection into Back-end Databases, cross-site scripting, cross-site request forging, authentication bypass, web services and related flaws, protective http headers Understanding Session Hijacking, Phases involved in Session Hijacking, Types of Session Hijacking, Session Hijacking Tools

HACKING WIRELESS NETWORKS   6 Hours

Introduction to 802.11, Role of WEP, Cracking WEP Keys, Sniffing Traffic, Wireless DOS attacks,

`

WLAN Scanners, WLAN Sniffers, Hacking Tools, Securing Wireless Networks

Theory: 30	Tutorial: 0	Practical: 30	Project: 0	Total: 60 Hours

SAMPLE LAB EXPERIMENTS:
1. Working with Trojans, Backdoors
2. Foot Printing & port scanning
3. Password guessing and Password Cracking.
4. Understanding Data Packet Sniffers
5. Implement the SQL injection attack.
6. Denial of Service and Session Hijacking using Tear Drop, DDOS attack.
7. Wireless and mobile hacking and security

REFERENCES
1. Kimberly Graves, "Certified Ethical Hacker", Wiley India Pvt Ltd, 2013
2. Michael T. Simpson, "Hands-on Ethical Hacking & Network Defense", Course Technology, 2016
3. Rajat Khare, "Network Security and Ethical Hacking", Luniver Press, 2006
4. Ramachandran V, BackTrack 5 Wireless Penetration Testing Beginner's Guide (3rd ed.). Packt Publishing, 2011
5. Thomas Mathew, "Ethical Hacking", OSB publishers, 2003
6. Debdeep Mukhopadhyay and Rajat Subhra Chakraborty, "Hardware Security: Design, Threats, and Safeguards", CRC Press, 2015

ONLINE LEARNING MATERIALS
1. https://www.coursera.org/learn/ethical-hacking-essentials-ehe

`

L	T	P	J	C
3	0	0	0	3

COURSE OUTCOMES
After successful completion of this course, the students should be able to

CO1: Demonstrate a comprehensive understanding of electronic business models, including e-commerce, mobile commerce and its legal issues (K3)

CO2: InterpretCyberEthics and its significance in the context of technology and information systems. (K3)

CO3: Develop a solid foundation in the principles and concepts of cyber laws (K3)

CO4: Illustrate information Technology act and legislation addressing cybercrime, including laws pertaining to unauthorized access, hacking, identity theft, and online fraud slation. (K3)

Pre-requisite: Nil

COs	CO/PO MAPPING (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak											
	PROGRAMME OUTCOMES (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M											
CO2	M									M		
CO3	M											
CO4	M									M		

THEORY COMPONENT CONTENT

ELECTRONIC BUSINESS AND LEGAL ISSUES   9 Hours
Evolution and development in E-commerce, paper vs paper less contracts E-Commerce models-B2B, B2C, E security. Business, taxation, electronic payments, supply chain, EDI,E-markets, Emerging Trends.

CYBER ETHICS   9 Hours
The Importance of Cyber Law, Significance of Cyber Ethics, Need for Cyber regulations and Ethics, Ethics in Information society, Introduction to Artificial Intelligence Ethics: Ethical Issues in AI and core Principles, Introduction to Blockchain Ethics.

INTRODUCTION TO CYBER LAW   9 Hours
Evolution of computer Technology, emergence of cyber space. Cyber Jurisprudence, Jurisprudence and law, Doctrinal approach, Consensual approach, Real Approach, Cyber Ethics, Cyber Jurisdiction, Hierarchy of courts, Civil and criminal jurisdictions, Cyberspace-Webspace, Web hosting and web Development agreement, Legal and Technological Significance of domain Names, Internet as a tool for global access.

INFORMATION TECHNOLOGY ACT   9 Hours
Overview of IT Act, 2000, Amendments and Limitations of IT Act, Digital Signatures, Cryptographic Algorithm, Public Cryptography, Private Cryptography, Electronic Governance, Legal Recognition of Electronic Records, Legal Recognition of Digital Signature, Certifying Authorities, Cyber Crime and Offences, Network Service Providers Liability, Cyber Regulations Appellate Tribunal, Penalties and Adjudication.

CYBER LAW AND RELATED LEGISLATION   9 Hours
Patent Law, Trademark Law, Copyright, Software Copyright or Patented, Domain Names and

`

Copyright disputes, Electronic DataBase and its Protection, IT Act and Civil Procedure Code, IT Act and Criminal Procedural Code, Relevant Sections of Indian Evidence Act,

Relevant Sections of Bankers Book Evidence Act, Relevant Sections of Indian Penal Code, Relevant Sections of Reserve Bank of India Act, Law Relating To Employees And Internet, Alternative Dispute Resolution, Online Dispute Resolution(ODR).

REFERENCES
1. Cyber Laws: Intellectual property & ECommerce, Security-Kumar K, dominant Publisher, 2011.
2. Cyber Ethics4.0,Christoph Stuckelberger, Pavan Duggal, by Globethics, 2018.
3. Information Security policy& Implementation Issues, PHI, 2003.
4. Legal Dimensions of Cyber Space, Verma S,K ,Mittal Raman,Indian Law Institute, New Delhi, 2004.
5. Cyber Law- The law of Internet, Jonthan Rosenoer, Springer,2011.
6. The Right to Information Act 2005, S.R.Bhansali, Sudhir Naib,OUP India, 2011.
7. Cyber Crimes and Law Enforcement, Vasu Deva, Commonwealth Publishers, New Delhi, 2017.

ONLINE LEARNING MATERIALS
1. https://www.coursera.org/videos/business-of-cybersecurity-capstone/ OxfpG?query= CYBER+LAWS+AND+ETHICS
2. https://www.coursera.org/learn/business-of-cybersecurity-capstone/
3. https://www.coursera.org/programs/coursera-for-campus-faculty-ovg1y/learn/-security-principles

`

P20CAE0232   **SECURE SOFTWARE DEVELOPMENT**

L	T	P	J	C
2	0	2	0	3

COURSE OUTCOMES:

After successful completion of this course, the students should be able to

CO1: Demonstrate various vulnerabilities related to memory attacks. (K3)
CO2: Apply security principles in software development. (K3)
CO3: Evaluate the extent of risks. (K3)
CO4: Apply security principles in the testing phase of software development. (K3)
CO5: Use tools for securing software. (K3)

Pre-requisite: P20CAE0230 - Ethical Hacking and Network Defence

COs	CO/PO MAPPING (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak											
	PROGRAMME OUTCOMES (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	M										
CO2	S	M			M							
CO3	S	M			M							
CO4	S	M			M							M
CO5	S				S							

THEORY COMPONENT CONTENT

NEED OF SOFTWARE SECURITY AND LOW-LEVEL ATTACKS   6 Hours

Introduction - Software Assurance and Software Security –Threats to software security - Sources of software insecurity - Benefits of Detecting Software Security - Properties of Secure Software – Secure SDLC- Memory-Based Attacks: Low-Level Attacks Against Heap and Stack - Defense Against Memory-Based Attacks

SECURE SOFTWARE DESIGN   7 Hours

Requirements Engineering for secure software - SQUARE process Model – Requirements elicitation and prioritization- Isolating The Effects of Untrusted Executable Content – Stack Inspection – Policy Specification Languages – Vulnerability Trends – Buffer Overflow – Code Injection - Session Hijacking. Secure Design - Threat Modeling and Security Design Principles

SECURITY RISK MANAGEMENT   5 Hours

Risk Management Life Cycle – Risk Profiling – Risk Exposure Factors – Risk Evaluation and Mitigation – Risk Assessment Techniques – Threat and Vulnerability Management

SECURITY TESTING   8 Hours

Traditional Software Testing – Comparison - Risk Based Security Testing – Prioritizing Security Testing With Threat Modeling – Penetration Testing – Planning and Scoping - Enumeration – Remote Exploitation – Web Application Exploitation - Exploits and Client Side Attacks – Post Exploitation – Bypassing Firewalls and Avoiding Detection - Tools for Penetration Testing

SECURE PROJECT MANAGEMENT   4 Hours

Governance and security - Adopting an enterprise software security framework - Security andproject management - Maturity of Practice

SAMPLE LAB EXPERIMENTS:

1. Implement the SQL injection attack.

`

2. Implement the Buffer Overflow attack.
3. Implement Cross Site Scripting and Prevent XSS.
4. Perform Penetration testing on a web application to gather information about the system, then initiate XSS and SQL injection attacks using tools like Kali Linux.
5. Develop and test the secure test cases
6. Penetration test using kali Linux

REFERENCES:
1. Julia H. Allen, "Software Security Engineering", Pearson Education, 2009.
2. Evan Wheeler, "Security Risk Management: Building an Information Security Risk Management Program from the Ground Up", First edition, Syngress Publishing, 2011.
3. Chris Wysopal, Lucas Nelson, Dino Dai Zovi, and Elfriede Dustin, "The Art of Software Security Testing: Identifying Software Security Flaws (Symantec Press)", Addison-Wesley Professional, 2006.
4. Robert C. Seacord, "Secure Coding in C and C++ (SEI Series in Software Engineering)",Addison-Wesley Professional, 2005.
5. Jon Erickson, "Hacking: The Art of Exploitation", 2nd Edition, No Starch Press, 2008.
6. Mike Shema, "Hacking Web Apps: Detecting and Preventing Web Application Security Problems", First edition, Syngress Publishing, 2012.
7. Bryan Sullivan and Vincent Liu, "Web Application Security, A Beginner's Guide", Kindle Edition, McGraw Hill, 2012.
8. Lee Allen, "Advanced Penetration Testing for Highly-Secured Environments: The Ultimate Security Guide (Open Source: Community Experience Distilled)", Kindle Edition, Packt Publishing, 2012.

`

P20CAE0233   **NETWORK SECURITY ADMINISTRATION**

L	T	P	J	C
2	0	2	0	3

COURSE OUTCOMES
After successful completion of this course, the students should be able to
- **CO1:** Identify types of security attacks, services and mechanisms (K3)
- **CO2:** Interpret the implementation of Internetwork security model and its standards (K3)
- **CO3:** Illustrate Email privacy system and compare Pretty Good Privacy (PGP) and S/MIME (K3)
- **CO4:** Interpret the primary components of a Three-Tier Architecture and explain how they work together firewall environment. (K3)
- **CO5:** Explain how communication is secured and how traffic is routed in firewall environment (K3)

Pre-requisite: P20CAT2004 - Data Communications and Networks

COs	CO/PO MAPPING (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak											
	PROGRAMME OUTCOMES (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	S			S							
CO2	S	M	M									
CO3	S	M										
CO4	S	S			S							
CO5	S	M			S							

THEORY COMPONENT CONTENT
NETWORK SECURITY BASICS   **6 Hours**
Security Attacks (Interruption, Interception, Modification and Fabrication), Security Services (Confidentiality, Authentication, Integrity, Non-repudiation, access Control and Availability) and Mechanisms, A model for Internetwork security, Internet Standards and RFCs, Buffer overflow & format string vulnerabilities, TCP session hijacking, ARP attacks, route table modification, UDP hijacking, and man-in-the-middle attacks.

NETWORK SECURITY ALGORITHM   **6 Hours**
Conventional Encryption Principles, Conventional encryption algorithms, cipher block modes of operation, location of encryption devices, key distribution Approaches of Message Authentication, Secure Hash Functions and HMAC

EMAIL SECURITY   **6 Hours**
Email privacy: Good Privacy (PGP) and S/MIME.IP Security Overview, IP Security Architecture, Authentication Header, Encapsulating Security Payload, Combining Security Associations and Key Management.

NETWORK SECURITY MANAGEMENT   **6 Hours**
Deploying Smart Console - Security Management Server - Security Gateway - Configuring Objects in Smart Console-Establishing Secure Internal Communication - Managing Administrator Access - Managing Licenses - Creating a Security Policy -Configuring Order Layers.

NETWORK SECURITY CONFIGURATION   **6 Hours**
Configuring a Shared Inline Layer - Configuring NAT - Integrating Security with a Unified Policy - Elevating Security with Autonomous -Threat Prevention - Configuring a Locally Managed Site-

`

to-Site VPN - Elevating Traffic View - Monitoring System States - Maintaining the Security Environment.

| Theory: 30 | Tutorial: 0 | Practical: 30 | Project: 0 | Total: 60 Hours |

REFERENCES
1. Network Security Essentials (Applications and Standards) by William Stallings Pearson Education 2018.
2. Hack Proofing your network by Ryan Russell, Dan Kaminsky, Rain Forest Puppy, Joe Grand, David Ahmad, Hal Flynn Ido Dubrawsky, Steve W.Manzuik and Ryan Permeh, Wiley Dreamtech Published by Syngress, 2002.
3. Network Security and Cryptography: Bernard Menezes, CENGAGE Learning, 2010.
4. Network Security - Private Communication in a Public World by CharlienKaufman, Radia Perlman and Mike Speciner, Pearson/PHI 2002.
5. Cryptography and network Security, Third edition, Stallings, PHI/Pearson 4. Principles of Information Security, Whitman, Cengage Learning, 2006.

ONLINE LEARNING MATERIALS
1. https://www.checkpoint.com/mind/secureacademy#

SAMPLE LAB EXPERIMENTS:
1. Deploying SmartConsole
2. Installing a Security Management Server and Security Gateway
3. Managing Administrator Access
4. Configuring Objects in SmartConsole
5. Creating a Security Policy
6. Configuring NAT
7. Integrating Security with a Unified Policy
8. Elevating Security with Autonomous Threat Prevention
9. Configuring a Locally Managed Site-to-Site VPN
10. Elevating Traffic View
11. Monitoring System States and Maintaining the Security Environment

`

P20CAE0235   COMPUTER VISION

L	T	P	J	C
2	0	2	0	3

COURSE OUTCOMES:
After successful completion of this course, the students should be able to
CO1: Apply the fundamentals of computer vision to the formation and transformation of images.(K3)
CO2: Apply feature extraction Techniques in image and segmentation(K3)
CO3: Ability to perform smoothing and image equalisation (K4)
CO4: Compare various projection and object recognition methods.(K4)
CO4: Evaluate performance of computer vision algorithms in various applications(K4)

Pre–requisite: P20CAE0014 – Deep Learning Techniques and Applications

COs	CO/PO MAPPING (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak											
	PROGRAMME OUTCOMES (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	S	S									
CO2		S		S	S							
CO3				S		M	M					
CO4	S		M									
CO5			S			S			M			

THEORY COMPONENT CONTENT

INTRODUCTION   **6 Hours**
Image Processing, Computer Vision - Low-level, Mid-level, High-level, Fundamentals of Image Formation, Transformation: Orthogonal, Euclidean, Affine, Projective, Fourier Transform, Convolution and Filtering, Image Enhancement, Restoration, Histogram Processing.

FEATURE EXTRACTION AND FEATURE SEGMENTATION   **6 Hours**
Feature Extraction -Edges - Corners - Harris and Hessian Affine, Orientation Histogram, SIFT, SURF, HOG, GLOH, Scale-Space Analysis- Image Pyramids and Gaussian derivative filters, Gabor Filters and DWT. Image Segmentation -Region Growing, Edge Based approaches to segmentation, Graph-Cut, Mean-Shift, MRFs, Texture Segmentation.

IMAGES, HISTOGRAMS, BINARY VISION   **6 Hours**
Simple pinhole camera model – Sampling – Quantisation – Colour images – Noise – Smoothing – 1D and 3D histograms - Histogram/Image Equalisation - Histogram Comparison - Back-projection - k-means Clustering.

3D VISION AND MOTION   **6 Hours**
Methods for 3D vision – projection schemes – shape from shading – photometric stereo – shape from texture – shape from focus – active range finding – surface representations – point-based representation – volumetric representations – 3D object recognition – 3D reconstruction – introduction to motion – triangulation – bundle adjustment – translational alignment – parametric motion–spline-based motion- optical flow – layered motion.

APPLICATIONS   **6 Hours**
Overview of Diverse Computer Vision Applications: Document Image Analysis, Biometrics, Object Recognition, Tracking, Medical Image Analysis, Content-Based Image Retrieval, Video

`

Data Processing, Virtual Reality and Augmented Reality-Pretrained models- VGG-16- ResNet50.

REFERENCES
1. D. A. Forsyth, J. Ponce, "Computer Vision: A Modern Approach", Pearson Education.2 nd Edition ,2015.
2. Joseph Howse , Joe Minichino " Learning OpenCV 4 Computer Vision with Python 3: Get to grips with tools, techniques, and algorithms for computer vision and machine learning, Packt Publishing Limited 3rd Edition , 2020.
3. Richard Szeliski, "Computer Vision: Algorithms and Applications", Springer Verlag London Limited,2011.
4. Sonka M, Hlavac V, Boyle R, Image processing, analysis, and machine vision, Cengage Learning; 2014.

ONLINE LEARNING MATERIALS
1. https://archive.nptel.ac.in/courses/106/105/106105216/
2. https://www.coursera.org/programs/coursera-for-campus-faculty-ovg1y/learn/introduction-computer-vision-watson-opencv

LAB COMPONENT
Sample List of Experiments:
1. Detect the RGB color from a webcam using Python – OpenCV
2. Face Detection using Python and OpenCV with a webcam
3. Face and Hand Landmarks Detection using Python – Media pipe, OpenCV
4. Real-Time Edge Detection using OpenCV
5. Implement Canny Edge Detector in Python using OpenCV
6. Gun Detection using Python-OpenCV
7. Real-time object color detection using OpenCV

| **Theory: 30** | **Tutorial:0** | **Practical: 30** | **Project :0** | **Total:60 Hours** |

`

P20CAE0236	NATURAL LANGUAGE PROCESSING	L	T	P	J	C
		2	0	2	0	3

COURSE OUTCOMES
After successful completion of this course, the students should be able to
CO1: Apply lexical and parsing techniques to perform pre-processing steps of NLP(K3)
CO2: Apply appropriate statistical models for a given natural language application(K3)
CO3: Analyze various algorithms that suit any natural language for processing(K4)
CO4: Suggest appropriate pre-processing steps essential for the various applications
     involving natural language processing(K4)

Pre–requisite: P20CAE0014 – Deep Learning Techniques and Applications

COs	CO/PO MAPPING (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak											
	PROGRAMME OUTCOMES (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S											
CO2	S	M										
CO3	M		S		M							
CO4	M			S								

THEORY COMPONENT CONTENT

LEXICAL ANALYSIS AND MORPHOLOGY   9 Hours
Regular expression and Automata for string matching - Words and Word Forms - Morphology fundamentals - Morphological Diversity of Indian Languages - Morphology Paradigms - Finite State Machine / Transducers Based Morphology - Automatic Morphology Learning - Parts of Speech - N-gram Models - Hidden Markov Models.

SPEECH PROCESSING   9 Hours
Biology of Speech Processing - Place and Manner of Articulation - Word Boundary Detection - Argmax based computations - HMM and Speech Recognition - Text to Speech Synthesis - Rule based-Concatenative based approach.

PARSING   8 Hours
Parsing Theories of Parsing - Parsing Algorithms – Earley Parser - CYK Parser - Probabilistic Parsing - CYK - Resolving attachment and structural ambiguity - Shallow Parsing - Dependency Parsing - Named Entity Recognition - Maximum Entropy Models - Conditional Random Fields.

APPLICATIONS   4 Hours
Applications: Sentiment Analysis - Text Entailment - Machine Translation - Question Answering System - Information Retrieval - Information Extraction - Cross Lingual Information Retrieval (CLIR)

REFERENCES
1. Jurafsky Daniel, Martin James, "Speech and Language Processing", Second Edition, Tenth Impression, Pearson Education, 2018.

`

2. Christopher Manning, Schutze Heinrich, "Foundations of Statistical Natural Language Processing", MIT Press, 1999.
3. Sowmya Vajjala, Bodhisattwa Majumder, Anuj Gupta, Harshit Surana " Practical Natural Language Processing: A Comprehensive Guide to Building Real-World NLP Systems", Oreilly Publications, 2020.
4. Steven Bird , Ewan Klein , Edward Loper, "Natural Language Processing with Python: Analyzing Text with the Natural Language Toolkit". Oreilly Publications, 2007.

ONLINE LEARNING MATERIALS
1. https://www.udemy.com/course/nlp-natural-language-processing-with-python
2. https://www.coursera.org/specializations/natural-language-processing
3. https://www.edx.org/learn/natural-language-processing
4. https://www.simplilearn.com/natural-language-processing-training-course
5. https://www.mygreatlearning.com/nlp/free-courses

LAB COMPONENT
Sample List of Experiments:
1. Pre-processing of text (Tokenization, Filtration, Script Validation, Stop Word Removal, Stemming)
2. Morphological Analysis
3. N - gram model
4. POS tagging
5. Chunking
6. Named Entity Recognition
7. Applications

| Theory: 30 | Tutorial:0 | Practical: 30 | Project :0 | Total:60 Hours |

`

	L	T	P	J	C
P20CAE0237 **GENERATIVE AI**	2	0	2	0	3

COURSE OUTCOMES:
After successful completion of this course, the students should be able to

CO1: Acquire insights into the key technological trends driving generative AI models (K3)

CO2: Acquire the ability to apply effective prompt engineering techniques to enhance the performance and control the behaviour of generative AI models (K4)

CO3: Build, train and apply generative models and develop familiarity with platforms (K4)

CO4: Ability to comprehend ethical issues and limitations of generative AI models(K3)

Pre–requisite: P20CAE0014 – Deep Learning Techniques and Applications

COs	CO/PO MAPPING (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak											
	PROGRAMME OUTCOMES (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	M					M				M	M
CO2		S	S	M	S	S	M	S	M	M	M	
CO3			S	M	S	S	M	S	M	M	M	
CO4				M		S	M			M	M	M

THEORY COMPONENT CONTENT

INTRODUCTION TO GENERATIVE AI   5 Hours
Capabilities - History and Evolution -Benefits- Challenges - Applications of Generative AI – Tools for Text, Image Code, Audio and Video generation– Economic Potential of Generative AI - Use cases

PROMPT ENGINEERING TECHNIQUES AND APPROACHES   6 Hours
Prompt Creation -Writing effective prompts -Techniques for using text prompts: Zero shot and few-shot prompt techniques – Prompt engineering approaches: Interview pattern, Chain-of Thought, Tree-of Thought - Benefits of using text prompts - Challenges in generating meaningful and coherent prompts.

MODELS FOR GENERATIVE AI   7 Hours
Basics of Sequential data processing – Building blocks of Generative AI - Discriminative modelling – Generative modelling –Recurrent Neural Networks – Long Short-Term Memory (LSTM) Networks - Generative Adversarial Networks (GANs) - Variational Autoencoders (VAEs) – Transformer–based Models - Diffusion models- Applications

PLATFORMS FOR GENERATIVE AI   7 Hours
Introduction to Platforms – Features of platforms – Capabilities -Applications - Pre-trained Models - Challenges – Generation of Text to Text – Generation of Text to Image – Text to Code Generation – Explainable AI – Benefits – Use cases.

ETHICAL ISSUES AND LIMITATIONS OF GENERATIVE AI   5 Hours
Limitations of Generative AI – Issues and concerns – Considerations for Responsible Generative AI – Economic Implications – Social Implications – Future and professional Growth of Generative AI.

`

REFERENCES

1. Deep Learning: Teaching Machines to Paint, Write, Compose and Play, David Foster, 2023. 2nd edition. O'Reilly Media, Inc.
2. Deep Learning, Ian Goodfellow, Yoshua Bengio, Aaron Courville, MIT Press, 2016.
3. Hands-on Generative Adversarial Networks with Keras, Rafael Valle. Packt Publisher, 2019

ONLINE LEARNING MATERIALS

1. https://www.coursera.org/learn/generative-ai-introduction-and-applications?specialization=generative-ai-for-everyone
2. https://www.coursera.org/learn/generative-ai-prompt-engineering-for-everyone?specialization=generative-ai-for-everyone
3. https://www.coursera.org/learn/generative-ai-foundation-models-and-platforms?specialization=generative-ai-for-everyone
4. https://www.coursera.org/learn/generative-ai-ethical-considerations-and-implications?specialization=generative-ai-for-everyone

LAB COMPONENT

Sample List of Experiments:
1. Generate text using Generative AI
2. Text Generation using ChatGPT and Bard
3. Image Generation using GPT and Stable Diffusion
4. Code Generation
5. Experimenting with Prompts
6. Approaches in Prompt Engineering
   - Chain-of-Thought Approach
   - Interview Pattern Approach
   - Tree-of-Thought Approach
7. Effective Text Prompts for Image Generation
8. Develop AI Applications with the Foundation Models
9. Develop AI Applications for Code Generation

Theory: 30	Tutorial:0	Practical: 30	Project :0	Total:60 Hours

`

P20CAE0038   RESPONSIBLE AI

L	T	P	J	C
3	0	0	0	3

COURSE OUTCOMES
After successful completion of this course, the students should be able to

CO1: Comprehend the fundamental concepts of AI, recognize ethical considerations, and analyze biases and limitations through real-world case studies.(K3)

CO2: Apply ethical theories and principles to implement responsible AI practices, emphasizing accountability, responsibility, and transparency.(K3)

CO3: Evaluate the importance of interpretability, categorize methods, and apply them to models, ensuring effective communication of results.(K3)

CO4: Attain a comprehensive understanding of data privacy principles, employ effective privacy-preserving techniques in AI applications, and critically assess real-world instances emphasizing the equilibrium between privacy and utility.(K4)

CO5: Assess ethical reasoning approaches, design moral agents, and implement ethical deliberation, governance, and inclusion for responsible AI practices.(K4)

Pre–requisite: P20CAT2003 – Data Intensive Computing

COs	CO/PO MAPPING (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak											
	PROGRAMME OUTCOMES (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	S	M	M	M	S	S		S	S	S	S
CO2	S	S	M	M	M	S	S		S	S	S	S
CO3	S	S	M	M	M	S	S		S	S	S	S
CO4	S	S	M	M	M	S	S		S	S	S	S
CO5	S	S	M	M	M	S	S		S	S	S	S

THEORY COMPONENT CONTENT

INTRODUCTION   **11 Hours**
Autonomy – Adaptability – Interaction – Need for Ethics in AI - Fairness and Bias: Sources of Biases – Exploratory data analysis, limitations of a dataset – Group fairness and individual fairness – Counterfactual fairness - AI harms – AI risks : Case Study.

ETHICAL DECISION MAKING   **8 Hours**
Seven Principles of Responsible AI - Ethical theories – Values - Ethics in practice – Implementing Ethical Reasoning – The ART of AI: Accountability, Responsibility, Transparency

INTERPRETABILITY AND EXPLAINABILITY   **10 Hours**
Importance of Interpretability – Taxonomy of Interpretability Methods – Scope of Interpretability – Evaluation of Interpretability – Interpretable Models: Linear Regression – Logistic Regression – Decision Tree.

PRIVACY PRESERVATION   **8 Hours**
Introduction to data privacy - Methods of protecting data - Importance of balancing data privacy and utility - Attack model – Privacy Preserving Learning - Differential Privacy – Federated Learning – Case Study.

`

ENSURING RESPONSIBLE AI   **8 Hours**
Approaches to Ethical Reasoning by AI – Designing Artificial Moral Agents – Implementing Ethical Deliberation – Levels of Ethical Behaviour – The ethical status of AI system – Governance for Responsible AI – Codes of Conduct – Inclusion and Diversity.

REFERENCES
1. Virginia Dignum, "Responsible Artificial Intelligence: How to Develop and Use AI in a Responsible Way" Springer Nature, 2019.
2. Christoph Molnar "Interpretable Machine Learning", Lulu, 1st edition, 2019.
3. Beena Ammanath, "Trustworthy AI", Wiley, 2022.
4. Adnan Masood, Heather Dawe, Dr. Ehsan Adeli, "Responsible AI in the Enterprise", Packt Publishing, 2023.

ONLINE LEARNING MATERIAL
1. https://www.coursera.org/programs/coursera-for-campus-faculty-ovg1y/learn/introduction-to-responsible-ai?source=search.
2. https://www.coursera.org/programs/coursera-for-campus-faculty-ovg1y/learn/responsible-ai-in-generative-ai?source=search

`

P20CAE0239   **PRINCIPLES OF DATA SCIENCE**

L	T	P	J	C
2	0	2	0	3

COURSE OUTCOMES

After successful completion of this course, the students should be able to

CO1: Analyze the concepts of Data, Data Description, Relationship and Data Wrangling(K4)

CO2: Apply appropriate statistical tests to evaluate hypotheses related to means, proportions, and variances. (K3)

CO3: Apply the knowledge on relationships between data. (K3)

CO4: Apply the advanced Data Wrangling techniques for data(K3).

Pre-requisite: Nil

COs	CO/PO MAPPING (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak											
	PROGRAMME OUTCOMES (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	S	M	M	S		S		S	M		
CO2	S	S	S	S	S		S		S	S		
CO3	S	S	S	S	S		S		S	S		
CO4	S	S	S	S	S		S		S	M		

THEORY COMPONENT CONTENT

INTRODUCTION   6 Hours

Overview of Data science–Research goals–Building the model– presenting findings and building applications - Data Mining - Data Warehousing -Retrieving data–Data preparation Big Data and Data Science - Big Data Analytics, Business intelligence vs Big data, big data frameworks, Current landscape of analytics.

DATA DESCRIPTION   6 Hours

Exploratory Data Analysis -statistical measures- Representation- Data Analytics Lifecycle-Developing Initial Hypotheses-Identifying Potential Data Sources- testing hypotheses on means, proportions and variances.

DESCRIBING RELATIONSHIPS   7 Hours

Correlation–Scatterplots–correlationcoefficientforquantitativedata–computationalformula   for correlation coefficient – Regression –Regression line –least squares regression line – Standard error of estimate – interpretation of r2 –multiple regression equations –Regression towards the mean.

ADVANCED DATAWRANGLING   8 Hours

Strings–Datetimes–Hierarchical Indexing–Visualizing data Frames – Pandas Profiling – Data Transformation-handling Null values-categorical values-Data Aggregation-Data Filtering-handling Outliers.

Theory:30	Tutorial:0	Practical:0	Project: 0	Total:30Hours

REFERENCES

   1. David Cielen, Arno D. B. Meysman, and Mohamed Ali, "Introducing Data Science", Manning Publications, 2016.

`

2. Robert S. Witte and John S. Witte, "Statistics", Eleventh Edition, Wiley Publications, 2017.
3. Jake VanderPlas, "Python Data Science Handbook", O'Reilly, 2016.
4. Allen B. Downey, "Think Stats: Exploratory Data Analysis in Python", Green Tea Press,2014.

ONLINE LEARNING MATERIALS
1. https://www.coursera.org/specializations/data-science
2. https://www.coursera.org/professional-certificates/fractal-data-science

SAMPLE LAB COMPONENTS
1. Data Retrieval and Preparation (Using Pandas)
2. Perform Exploratory Data Analysis on a dataset, exploring variables and visualizing distributions.
3. Calculate correlation coefficients between variables in a dataset
4. Create scatter plots and correlation matrices using Python
5. Implement simple linear regression on a dataset using Python's scikit-learn
6. Evaluate and interpret regression mode

`

	P20CAE0240	**DATA PROCESSING TECHNIQUES**	L	T	P	J	C
			2	0	2	0	3

COURSE OUTCOMES

After successful completion of this course, the students should be able to

CO1: Analyze the data processing concepts in data science .(K4)

CO2: Apply the Real time data processing in machine learning model(K3)

CO3: Illustrate the change Data capture Techniques and Strategies in Incremental Processing. (K4)

CO4: Apply the Learning algorithms for incremental processing in data.(K3)

CO5: Correlating the Traditional disk system with In-Memory Database(K4)

Pre-Requisite:Nil

COs	CO/PO MAPPING (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak											
	PROGRAMME OUTCOMES (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	S					S	S		M	S	
CO2	S	S		S								
CO3	S		S									
CO4	S			S								
CO5												

THEORY COMPONENT CONTENT

DATA PROCESSING   8 Hours

Overview of Data processing in Data science–Importance of Efficiency and Scalability –challenges in Big Data Processing–Parallel and Distributed Processing –Apache Hadoop– Map reduce – Integration of Data mining system with a Data warehouse–Major issues in Data Mining–Data Preprocessing.

REAL TIME DATA PROCESSING   7 Hours

Streaming Data Architectures–Message Brokers –Pub/Subsystems–Queues– Apache-Kafka for Real Time Data streaming– Producers-consumers-Kafka connect for Data Integration-stream processing-Frame works-Real Time analytics -Machine learning models.

INCREMENTAL PROCESSING   7 Hours

Incremental processing in Data science–Change Data Capture Techniques (CDC)-Strategies-Delta Processing for incremental updates- Incremental Learning algorithms.

IN-MEMORY PROCESSING   8 Hours

Principles of In-Memory Processing-comparisons Of Traditional Disk based systems -In-Memory database and data structures-In-Memory computing in spark-Resilient Distributed datasets(RDD) And Data frames-In-Memory analytics with SAP HANA-Performance Tuning and optimization .

REFERENCES

1. "Practical Real-time Data Processing and Analytics: Distributed Computing and Event Processing using Apache Spark, Flink, Storm, and Kafka", by Shilpi Saxena and Sharub Gupta, 1st Edition, Kindle Edition 2017.
2. "Data Warehouse ETL Toolkit: Practical Techniques for Extracting, Cleaning, Conforming, and Delivering Data" by Ralph Kimball and Joe Caserta, 1st Edition 2004.
3. Building a Scalable Data Warehouse with Data Vault 2.0", by Dan Linstedt ,2015.

`

4. "High Performance Spark: Best Practices for Scaling and Optimizing Apache Spark" by Holden Karau, Rachel Warren, 1st edition, 2017.

ONLINE LEARNINGMATERIALS
1. https://www.coursera.org/videos/big-data-integration-processing/zBKt2?query=IN+MEMEORY+DATA+PROCESSING&source=search
2. https://www.coursera.org/videos/machine-learning-accounting-python/j3M5H?source=search&source=search&query=data%20preprocessing

SAMPLE LAB CONTENTS   30 Hours
1. Implement a program using the environment Apache Flink
2. Implementation of producer and consumer program using Kafka
3. Implement a simple flink streaming application.
4. Explore and connect flink application to kafka for Real time data ingestion
5. Design and Deploy simple strom topology
6. Develop a real-time analytics application with a simple machine learning model.
7. Implement mechanisms for model updates in response to streaming data changes.

| Theory:30 | Tutorial:0 | Practical:30 | Project:0 | Total:60 Hours |

`

P20CAE0241   **DATA MODELING**

L	T	P	J	C
2	0	2	0	3

<u>**COURSE OUTCOMES**</u>
After successful completion of this course, the students should be able to
CO1: Apply MySQL Workbench to design database model(K3)
CO2: Apply logical Data model to design Patterns(K3)
CO3: Design Geospatial data models for applications involving location-based   analytics(K6)
CO4: Analyze and choose appropriate NoSQL and NewSQL databases for specific
          modeling requirements.(K4)

Pre-requisite: Nil

COs	CO/PO MAPPING (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak											
	PROGRAMME OUTCOMES (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1					S							
CO2					S							
CO3	S	S	S							S		
CO4	S	S	S		S							

THEORY COMPONENT CONTENT

INTRODUCTION TO ADVANCED DATA MODELING   **6 Hours**
Overview of Data Modeling in Data science– Importance of Advanced data Modeling – Types of data Model– Dimensional modelling-Design-MySQL Workbench-Build Data model using MySQL workbench–Forward Engineering Feature-Converting Data model into Database schema, MySQL to reverse Engineering schema.

LOGICAL DATA MODEL   **6 Hours**
Cross enterprise Analysis- Modern Driven analysis -Baseline data patterns-complex data Patterns-Generation of Entity Types -Transition from meta data to data-static vs dynamic Entity types-data coupling -cohesion.

ADVANCED DATA PATTERNS   **6 Hours**
Advanced subtype variations-Multi recursive networks-conditional Recursions-Rules based entity types-state Transition rules-Meta patterns.

GRAPH AND TEMPORAL DATA MODELING   **6 Hours**
Graph Databases – Nodes – Edges – Properties– Graph query Languages – Understanding Temporal Databases–Valid time vs Transition Time–Temporal Datamining Techniques–Temporal query languages; No-SQL-New SQL: CAP theorem – Document-based: MongoDB data model and CRUD operations.

GEOSPATIAL AND METADATA MODELING   **6 Hours**
Representing geospatial data in models-Geospatial Query Language-Applications in Mapping and Location-based Analytics-Metadata Definition and Importance-Encryption and Masking in Data Models-Access Controls and Authorization.

REFERENCES
1. The Data Warehouse Toolkit: The Definitive Guide to Dimensional Modeling". Authors: Ralph Kimball and Margy Ross 2013 3rd Edition.
2. Designing Data-Intensive Applications: The Big Ideas Behind Reliable, Scalable, and

`

Maintainable Systems (Greyscale Indian Edition) 2017.
3. Data Modeling Made Simple: A Practical Guide for Business & IT Professionals Authors: Steve Hoberman: 2nd Edition,2009.

ONLINE LEARNING MATERIALS
1. https://www.coursera.org/lecture/advanced-data-modeling/introduction-to-advanced-data-modeling-eqENZ
2. https://www.coursera.org/learn/sql-data-science
3. https://www.coursera.org/learn/advanced-data-modeling
4. https://www.coursera.org/learn/nosql-databases
5. https://www.coursera.org/specializations/databases-for-data-scientists

SAMPLE LAB CONTENTS   30 Hours
1. Explore a sample dataset and identify dimensions and facts.
2. Design and Implement schema for a dataset using MySQL workbench.
3. Design and implement a graph Data model for any dataset.
4. Implement a temporal data model for historical dataset
5. create Geospatial data models for location analyses
6. Explore the GEOJSON to represent spatial data.
7. create and manage a metadata for given dataset

Theory:30	Tutorial:0	Practical:30	Project:0	Total:60 Hours

.

P20CAE0242   **DATA ANALYSIS AND VISUALIZATION**

L	T	P	J	C
2	0	2	0	3

COURSE OUTCOMES
After successful completion of this course, the students should be able to

CO1: Use the Exploratory data analysis concepts over the data(K3)

CO2: Apply the data visualization using Matplotlib.(K3)

CO3: Illustrate univariate data exploration and analysis. (K4)

CO4: Apply bivariate data exploration and analysis. (K3)

CO5: Use Data exploration and visualization techniques for multivariate and time series data. (K3)

Pre-requisite: P20CAE0239 - Principles of Data science

COs	CO/PO MAPPING (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak											
	PROGRAMME OUTCOMES (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1					S							
CO2					S							
CO3	S	S	S							S		
CO4	S	S	S		S							
CO5					S							

THEORY COMPONENT CONTENT

EXPLORATORY DATA ANALYSIS FUNDAMENTALS   6 Hours
Overview – Significance of Exploratory Data Analysis(EDA) – Making sense of data– Comparing EDA with classical and Bayesian analysis –Software tools forEDA-VisualAidsforEDA-Datatransformationtechniques-mergingdatabase,reshaping and pivoting, Transformation techniques-Grouping Datasets-data aggregation–Pivot tables and cross-tabulations.

VISUALIZING USING MATPLOTLIB   6 Hours
Importing Matplotlib – Simple line plots – Simple scatter plots – visualizing errors – density and contour plots – Histograms – legends – colors – subplots – text and annotation – customization – three-dimensional plotting - Geographic Data with Basemap - Visualization with Seaborn.

DASHBOARD CREATION USING POWERBI   6 Hours
Creating Reports-table Visualization-Bar –Pie-column-donut –Navigation and accessibility-Bringing data to the user-Identifying Patterns and trends-case study.

UNIVARIATE & BIVARIATE ANALYSIS   6 Hours
Introduction to Single variable: Distributions and Variables – Numerical Summaries of Level and Spread - Scaling and Standardizing – Inequality - Smoothing Time Series. Relationships between Two Variables - Percentage Tables - Analyzing Contingency Tables - Handling Several Batches - Scatterplots and Resistant Lines – Transformations.

MULTIVARIATE AND TIME SERIES ANALYSIS   **6 Hours**

Introducing a Third Variable-Causal Explanations-Three-Variable Contingency Tables and Beyond - Longitudinal Data – Fundamentals of TSA – Characteristics of time series data – Data Cleaning – Time-based indexing – Visualizing – Grouping – Resampling.

Theory:30	Tutorial:0	Practical:	Project: 0	Total: 60 Hours

REFERENCES

1. Suresh Kumar Mukhiya, Usman Ahmed, "Hands -On Exploratory Data Analysis with Python", Packt Publishing, 2020.
2. Jake Vander Plas, "Python Data Science Handbook: Essential Tools for Working with Data", Oreilly, 1st Edition, 2016.
3. Catherine Marsh, Jane Elliott, "Exploring Data: An Introduction to Data Analysis for Social Scientists", Wiley Publications, 2nd Edition, 2008.

ONLINE LEARNING MATERIALS

1. https://www.coursera.org/specializations/data-analysis-visualization-foundations
2. https://www.coursera.org/learn/data-analysis-and-visualization-with-power-bi
3. https://onlinecourses.nptel.ac.in/noc22_cs32/preview.

LAB CONTENTS   **30 Hours**

1. Implementation of Descriptive statistics for a dataset.
2. Implementation of Inferential statistics for a Dataset.
3. Implementation of data charts–Univariate analysis
4. Implementation of data visualization techniques–Bivariate Analysis
5. Implementation of data visualization techniques–multivariate Analysis
6. Implementation the Handling outliers and missing values
7. Implement Visual encoding of data
8. Develop a Dashboard for various domain

L	T	P	J	C
2	0	2	0	3

P20CAE0243　　　　**BUSINESS INTELLIGENCE FOR DECISION MAKING**

COURSE OUTCOMES
After successful completion of this course, the students should be able to
CO1: Analyze the real world business problems and model with analytical solutions.(K4)
CO2: Evaluate the business processes for extracting Business Intelligence(K4)
CO3: Apply predictive analytics for business fore-casting.(K3)
CO4: Apply analytics for supply chain and logistics management(K3)
CO5: Use analytics for marketing and sales.(K3)

Pre-Requisite: P20CAE0242 – Data Analysis and Visualization

COs	CO/PO MAPPING (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak											
	PROGRAMME OUTCOMES (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

THEORY COMPONENT CONTENTS

INTRODUCTION TO BUSINESS ANALYTICS　　　　　　　　　6 Hours
Analytics and Data Science – Types of Analytics – Business Problem Definition – Data Collection – Data Preparation – Hypothesis Generation – Modeling – Validation and Evaluation – Interpretation – Deployment and Iteration

BUSINESS INTELLIGENCE　　　　　　　　　　　　　　　6 Hours
Data Warehouses and Data Mart - Knowledge Management –Types of Decisions - Decision Making Process - Decision Support Systems – Business Intelligence –OLAP – Analytic functions.

BUSINESS FORECASTING AND COMPETITIVE ANALYSIS　　　6 Hours
Introduction to Business Forecasting and Predictive analytics - Logic and Data Driven Models– Data Mining and Predictive Analysis Modelling –Machine Learning for Predictive analytics- Industry analysis- Profit Frontier, Risk vs Return, Competition Positioning- Enterprise Diagnosis

HR ANALYTICS　　　　　　　　　　　　　　　　　　6 Hours
Human Resources – Planning and Recruitment – Training and Development - Supply chain network-Planning, Demand,Inventory,and,Supply–Logistics–Analyticsbapplications in HR-Applying HR Analytics to make a prediction of the demand for talent.

MARKETING &SALES ANALYTICS   **6 Hours**

Marketing Strategy, Marketing Mix, Customer Behaviour –selling Process –Sales Planning–
Analytics applications in Marketing and Sales - predictive analytics for customers' behaviour
in marketing and sales.

REFERENCES

1. R.Evans James,BusinessAnalytics,2ndEdition,Pearson,2017.
2. RN Prasad, Seema Acharya, Fundamentals of Business Analytics,2nd Edition,
   Wiley,2016.
3. Philip Kotler and Kevin Keller, Marketing Management,15th edition, PHI,2016.
4. VSP Rao, Human Resource Management,3rd Edition, Excel Books,2010.
5. Mahadevan B, "Operations   Management -Theory and Practice", 3rd Edition,
   Pearson Education, 2018.

Theory:30	Tutorial:0	Practical:30	Project:0	Total:60Hours

ONLINE LEARNING MATERIALS

1. https://www.coursera.org/learn/data-analytics-business
2. https://www.coursera.org/learn/foundations-of-business-intelligence
3. https://www.coursera.org/specializations/bi-foundations-sql-etl-data- warehouse

SAMPLE LAB CONTENTS   **30 Hours**

1. Explore the interface and basic features of the BI tool(Qlik)
2. Load and visualize a sample dataset.
3. Import a dataset into the BI tool. And Cleanse data by handling missing values, outliers, and
   inconsistencies.
4. Transform data to suit BI reporting requirements and Design a dashboard with key
   performance indicators (KPIs).
5. Develop interactive dashboards for dynamic data exploration.
6. Integrate data from various sources for comprehensive analysis
7. Implement advanced chart types (treemaps, heatmaps, etc.).
8. Apply BI tools for forecasting and predictive analytics.

P20CAE0044	DATA ETHICS AND PRIVACY	L	T	P	J	C
		3	0	0	0	3

COURSEOUTCOMES

After successful completion of this course, the students should be able to

CO1: Develop an awareness of the impact of data-related decisions on individuals and society. (K6)

CO2: Identify the challenges and consequences of Biased datasets. (K4)

CO3: Examine the importance of Data security and Accuracy. (K3)

CO4: Apply the aspects of distributed data and associated risks. (K3)

CO5: Apply the knowledge of encryption for data.(K3)

PreRequisite:Nil

COs	CO/PO MAPPING (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak											
	PROGRAMME OUTCOMES (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S		M				M		M			
CO2	S		M				M		M			
CO3		S		M								
CO4		S		M								
CO5												

THEORY COMPONENT CONTENT

DATABIAS   8 Hours

Introduction- Data vs Information vs Facts- Algorithmic Bias- Privacy- Biased Datasets-PurposeofCorporation/AI-Fairness,PredictiveAnalytics&Mistakes-Surveillance&Power-Disparate Treatment/Impact

ETHICS IN DATA SCIENCE   9 Hours

Ethics in data management- Role of AI Ethics in Corp- Privacy & Shared Responsibility-Surveillance/Power and Shared Responsibility- Disparate Treatment/Impact- Economics of Trust- Transparency vs accountability.

ACCURACY AND PRIVACY   10 Hours

Creating & Measuring Accuracy-Data Science Ethics-Data Science Hate Privacy-Respecting Data Science- Misconceptions About Data Science Ethics- Accountability and Governance- Data Provenance and Aggregation

PRIVACY ATTACKS   9 Hours

Defining Differential Privacy- Privacy Loss- Privacy attacks- Types of privacy attacks- Privacy-Aware Machine Learning and Data Science- Architecting Privacy in Data and Machine Learning- Open Source Libraries for PPML Projects- Distributed Data- Federated Learning

DATAENCRYPTION FOR PRIVACY   9 Hours

Encrypted Computation- Types of Encrypted Computation- Real-World Encrypted

`

Computation- Navigating the Legal Side of Privacy- GDPR: An Overview- Privacy and Practicality Considerations- Getting Practical: Managing Privacy and Security Risk.

Theory:45	Tutorial:0	Practical:0	Project: 0	Total: 45 Hours

REFERENCES
1. Katharine Jarmul, Practical Data Privacy Released April 2023 Publisher(s): O'Reilly Media, Inc. ISBN: 9781098129460
2. Loukides, Mike,HilaryMason,andDJPatil.2018.EthicsandDataScience. Sebastopol, CA: O'Reilly Media.

ONLINE LEARNING MATERIALS

1. https://www.coursera.org/learn/data-science-ethics
2. https://www.coursera.org/learn/northeastern-data-privacy

`

	L	T	P	J	C
	2	0	2	0	3

P20CAE0245   **SMART CONTRACT DEVELOPMENT**

<u>COURSE OUTCOMES</u>
After successful completion of this course, the students should be able to
CO1: Interpret Ethereum components required to design a smart contract. [K3]
CO2: Design and develop smart contracts using Solidity programming. [K3]
CO3: Create and deploy a DApp on a Ethereum test network. [K3]
CO4: Deploy and manage Ethereum blockchain networks using Ganache and Truffle. [K3]

Pre-requisite: P20CAE0008- Blockchain Technologies

COs	CO/PO MAPPING (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak											
	PROGRAMME OUTCOMES (POs)											
	PO1	PO2	PO 3	PO4	PO5	PO6	PO7	PO8	PO9	PO1 0	PO1 1	PO1 2
CO1	S									M		
CO2	S		M							M		
CO3	S	M	M		M	S	S		M	M		
CO4	S	S	S		M	S	S	M	S	M	S	

THEORY COMPONENT CONTENT

ETHEREUM FOUNDATIONS   8 Hours
Ethereum Eco System – Components – Ethereum Virtual Machine (EVM) – Ethereum and Turing Completeness – Smart Contract Basics – Smart Contract Lifecycle – Structure of Smart Contract. Ether currency units - Ethereum wallets – Ethereum accounts – Ethereum Tokens – Transactions, Gas and Fees – Ethereum mining - Externally owned accounts and contracts.

SMART CONTRACT DEVELOPMENT   11 Hours
Building a smart contract with Solidity – Ethereum Contract ABI – Programming with Solidity: Data Types & Variables – Operators – Control Structures - Predefined Global variables – Storage & Memory - Contracts – Functions – Function Modifiers - Constructor – Inheritance - Events and logs – Error handling - Inter-contract execution - Libraries and Ethereum package manager – Tokens - Introduction to Ethereum Name Service (ENS) – Designing Smart Contracts.

BUILDING DAPP AND WEB 3   11 Hours
Running an Ethereum Client: Go Ethereum (Geth) - Processing and deploying smart contracts in Remix IDE. Introduction to Web3 - Using the web3.js javascript library - Generating Ethereum accounts.
Truffle Framework & Ganache: Environment Setup for Truffle & Ganache, Truffle Project Creation, – Truffle Compile – Migrate and Create Commands - Decentralized App Creation: Smart Contract Creation, Front-End Creation, Connecting Smart Contract with Front-End

`

Application – Deploying DApp – Validation – Testing of DApp.

REFERENCES
1. Mastering Ethereum: Building Smart Contracts and DApps by Andreas M. Antonopoulos, Gavin Wood, 2018, O'Reilly Media.
2. Modi, Ritesh, Solidity Programming Essentials: A beginner's guide to build smart contracts for Ethereum and Blockchain, 2018, Packt Publishing Ltd, United Kingdom.
3. Imran. Bashir. Mastering block chain: Distributed Ledger Technology, Decentralization, and Smart Contracts Explained. Packt Publishing, 2nd Edition, 2018.

ONLINE LEARNING MATERIALS
1. https://www.coursera.org/learn/decentralized-apps-on-blockchain?specialization=blockchain
2. https://www.coursera.org/learn/smarter-contracts#syllabus
3. https://101blockchains.com/course/smart-contracts-development
4. https://www.tcsion.com/courses/industry-honour-course/ethereum-smart-contracts/
5. https://onlinecourses.swayam2.ac.in/aic21_ge01/preview
6. https://trufflesuite.com/docs/truffle/

Sample List of Experiments   **30 Hours**
1. Getting Started with MetaMask
     a. Creating a Wallet
     b. Interacting with Remix IDE
     c. Switching Networks
     d. Getting some Test Ethers
     e. Sending Ether from MetaMask
     f. Exploring the transaction details of an account
2. Building smart contract using Solidity, compiling and deploying it on Remix IDE
3. Use of setter and getter functions to interact with the contracts.
4. Smart contract to withdraw funds from a contract to a restricted account, preferably the owner's, with different levels of security restrictions.
5. Build a DApp and deploy a smart contract on an external blockchain by using Ganache and Truffle. Interact with a front end developed using Web 3.js.

Theory:30	Tutorial:0	Practical:30	Project:0	Total: 60 Hours

	L	T	P	J	C
P20CAE0046 **DECENTRALIZED FINANCE**	3	0	0	0	3

<u>**COURSE OUTCOMES**</u>

After successful completion of this course, the students should be able to

CO1: Interpret the features of decentralized finance required to build its infrastructure. [K3]

CO2: Examine key trends and basic primitives of decentralized finance to design innovative financial solutions. [K3]

CO3: Apply diverse DeFi operations for providing blockchain-based financial solutions. [K3]

CO4: Identify the risks associated with decentralized finance. [K3]

CO5: Analyse ethical and regulatory issues associated with Decentralized Finance. [K4]

Pre-requisite: P20CAE0008- Blockchain Technologies

COs	CO/PO MAPPING (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak											
	PROGRAMME OUTCOMES (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M											
CO2	S	M					M					
CO3	S	M							M	M	M	
CO4	M			M		M			M	M	M	
CO5	M			M		M			M	M	M	

THEORY COMPONENT CONTENT

DECENTRALIZED FINANCE(DEFI) INFRASTRUCTURE   **8 Hours**

Issues in Centralized Finance – History and Overview of Decentralized Finance - Overview of Cryptocurrency – Cryptographic hashing – Proof of work – Smart Contracts – Gas - Stable coins – Tokenomics – Altcoins - Blockchain and DeFi.

DEFI PRIMITIVES   **8 Hours**

Transactions – Fungible tokens – Non Fungible tokens – custody – Supply adjustment – Incentives – Swap – Collateralized loans – Flash loan - Problems solved by DeFi- Inefficiency – Limited Access – Opacity – Centralized control and lack of Interoperability.

DEFI OPERATIONS   **10 Hours**

Credit /Lending and borrowing protocols – Decentralized Exchanges – Derivatives – Tokenization – Hot and cold wallets – Moving centralized exchanges funds to blockchain - Automated market makers – Bridging – Staking – Oracles.

DECENTRALIZED IDENTITY AND SECURITY   **10 Hours**

Decentralized Identity (DID) – Security risks and measures in DeFi – Smart contract risk - Governance risk – Oracle risk – scaling risk – DEX risk – Custodial risk – Regulatory risk. Smart Contract Auditing – Yield Farming strategies – Liquidity mining.

REGULATORY AND ETHICAL CONSIDERATIONS   **9 Hours**

Global Regulations – Ethical issues – DAO – Government mechanisms – Crypto hackers – DeFi Use cases -Case study: Crypto Exchange Platforms and Gitcoin.

REFERENCES
1. Campbell R. Harvey, Ashwin Ramachandran, Joey Santoro, Vitalik Buterin, "DeFi and the Future of Finance", Wiley 1st Edition.
2. Melanie Swan, Blockchain: Blueprint for a new economy, Shroff Publisher/O'Reilly Publisher.
3. Ron Quaranta, Blockchain in Financial Markets and Beyond: Challenges and Applications, Risk Books Publisher.
4. Richard Hayen, Blockchain & FinTech: A Comprehensive Blueprint to Understanding Blockchain & Financial Technology - Bitcoin, FinTech, Smart Contracts, Cryptocurrency, Risk Books Publisher.

ONLINE LEARNING MATERIALS
1. https://www.udemy.com/course/masteringdefi/
2. https://www.coursera.org/specializations/decentralized-finance-duke
3. https://101blockchains.com/ebooks/decentralized-finance-defi-guide/

Theory:45	Tutorial:0	Practical:0	Project:0	Total: 45 Hours

`

P20CAE0247   VIRTUALIZATION AND RESOURCE MANAGEMENT

L	T	P	J	C
2	0	2	0	3

COURSE OUTCOMES

After successful completion of this course, the students should be able to

CO1: Analyze the use of different resource virtualizations used in cloud environment (K4).
CO2: Apply the factors of cloud economics on migration and development (K3).
CO3: Develop applications in different public cloud platform (K3).
CO4: Select appropriate service model for an application(K3).
CO5: Choose a suitable cloud service provider based on application domain(K3).

Prerequisite: Nil

COs	CO/PO MAPPING (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak											
	PROGRAMME OUTCOMES (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S				M	M	S	M				
CO2	S	M					S	M				
CO3	S			M		M	S			M	M	
CO4	S	M			M		S	M				M
CO5	S		M	M		M		M				M

THEORY COMPONENT CONTENT

VIRTUALIZATION   4 Hours

Roles of Virtualization, Hypervisor, Types of Virtualization – Server virtualization – Storage virtualization – Network virtualization – Desktop virtualization – Application Virtualization.

CLOUD ECONOMICS AND MIGRATION   5 Hours

Cost models and optimization, Economies of Scale, Resource Optimization, Reduced Capital Expenditure - Total Cost of Ownership (TCO), Cost Transparency and Management, Risk Mitigation and Security, Performance vs. Cost Trade-offs.
Cloud Migration Strategies, Iterative Seven-step Model of Migration into the Cloud, Assessment and Planning, Choosing the Right Cloud services and Provider, Change Management and Training, Performance and Monitoring, Testing and Validation, Backups, Post-Migration Optimization.

INFRASTRUCTURE AS A SERVICE   7 Hours

Compute: AWS EC2, Azure Virtual Machines, Google Compute Engine. Containers – Microservices, Docker, Kubernetes containers. Storage: Amazon EBS, Amazon S3, Azure disk storage, Google cloud storage. Autoscaling – AWS autoscaling, Azure app service, Google compute engine. Load balancing – AWS ELB, Azure traffic manager, Google cloud load balancer. Network: Amazon VPC, Azure virtual network, Google cloud VPN.

PLATFORM AS A SERVICE   7 Hours

PaaS: Serverless computing - AWS Lambda, Azure functions, Google Cloud functions, AWS Apprunner, Elastic beanstalk, Google App engine, Google Cloud Functions, Amazon RDS, DynamoDB, Azure SQL database, Azure CosmosDB, Google cloud SQL, Google cloud database.

SOFTWARE AS A SERVICE   7 Hours

Amazon chime, Workmail, Workdocs, Microsoft 365, Microsoft power platform, Azure active directory, Azure DevOps, Azure IoT central, Azure cost management, Google Maps platform, Google workspace, Google analytics, Google cloud identity, Google Cloud search, Firebase.

Theory: 30	Tutorial:0	Practical: 30	Project:0	Total:60 Hours

REFERENCES:

1. Dr. Rajesh Kumar Pathak , "Cloud Computing Fundamentals, Notion Press, 2023.
2. A. B. Lawal, "Cloud Computing Fundamentals: Learn the Latest Cloud Technology and Architecture with Real-World Examples and Applications", A. B. Lawal publication, 2020.
3. Rajkumar Buyya, Christian Vecchiola, S.Thamarai Selvi, "Mastering Cloud Computing: Foundations and Applications Programming", Morgan Kaufmann publications, 2013.
4. Cloudonomics: The Business Value of Cloud Computing" by Joe Weinman, John Wiley & Sons Inc, 2012.
5. Mastering AWS Development" by Uchit Vyas, Ingram short title, 2015.
6. Microsoft Azure Essentials - Fundamentals of Azure, Second Edition" by Michael Collier and Robin Shahan, Microsoft Press, 2015.
7. Google Cloud Platform for Developers: Build highly scalable cloud solutions with the power of Google Cloud Platform" by Ted Hunter and Steven Porter, Packt Publishing Limited, 2018.

ONLINELEARNING MATERIALS

1. https://www.coursera.org/learn/cloud-computing-basics
2. https://www.coursera.org/learn/meta-cloud-computing
3. https://www.coursera.org/learn/cloud-computing-foundations-duke
4. https://www.coursera.org/browse/information-technology/cloud-computing
5. https://www.mygreatlearning.com/cloud-computing/courses
6. http://www.infocobuild.com/education/audio-video-courses/computer-science/CloudComputing-IIT-Kharagpur/lecture-12.html
7. https://www.coursera.org/specializations/aws-fundamentals
8. https://www.coursera.org/learn/cloud-azure-intro
9. https://www.coursera.org/learn/gcp-infrastructure-foundation

`

LAB CONTENTS:
Few exercises related to AWS, Azure, Google platform services that fall under IaaS, PaaaS and SaaS.
Sample Exercises:
1. Demonstrate the virtualization by enabling the OS virtualization on single machine by creating instances oracle virtual box/VMware.
2. Installation of VM Ware/ virtual box and implement multiple OS.
3. Creating VMs in public cloud.
4. Deploying application in Docker/Kubernetes.
5. Static Web site hosting
6. Dynamic Website hosting
7. Balancing network traffic using load balancer
8. Scale the Compute resource with auto scaling
9. E-mail notification using serverless architecture.
10. Configuring a cloud network

`

P20CAE0248   CLOUD INFRASTRUCTURE AND ARCHITECTURE

COURSE OUTCOMES

L	T	P	J	C
2	0	2	0	3

After successful completion of this course, the students should be able to

CO1: Construct the architecture for a private cloud. (K3)

CO2: Develop a cloud environment at small scale. (K3)

CO3: Inspect Security of services and applications in private cloud. (K4)

CO4: Make use of concepts and features related to Virtualized datacenter to configure cloud storage.(K3).

CO5: Build environment to manage IT resources. (K3)

Prerequisite: P20CAE0247 - **Virtualization and Resource Management**

COs	CO/PO MAPPING (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak											
	PROGRAMME OUTCOMES (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1			M			M		M			M	
CO2			M	M	M			M		M	M	
CO3			M		M			M		M	M	
CO4			M					M			M	
CO5			M		M			M		M	M	

THEORY COMPONENT CONTENT

INTRODUCTION TO CLOUD INFRASTRUCTURE   7 Hours

Introduction to cloud Infrastructure/virtual infrastructure, General Architecture of virtual infrastructure: Architecture of OpenStack, project, services, mode of deployment, workflow, Openstack Components: Nova, Swift, cinder, Nuetron, Glance, Keystone, Horizon.Virtualization environment with KVM. OpenStack API.

CLOUD COMPUTE ARCHITECTURE   7 Hours

Configuring Horizon Dashboard, OpenStack CLI client - Create and manage flavors, compute instances, generate and manage SSH keys, accessing instances, configure an instance with a floating IP address, create instances with security groups, manage Nova host consoles, instance snapshots.Openstack image service: image repository, manage images, metadata, image types, bundling, exporting, migrating images.

CLOUD STORAGE ARCHITECTURE   8 Hours

Swift: features, architecture of swift, swift installation and configuration, data management lifecycle, backup and archival, media storage with swift. Use the command line client to upload and manage files to Swift containers, manage permissions on a container in object storage,

Cinder: Architecture of cinder clock storage, Volume provisioning and management- create and manage volumes, attach volumes to instances, manage volume quotas, backup and restore volumes, manage volume snapshots.

`

CLOUD NETWORK ARCHITECTURE   8 Hours

Software defined networking, Neutron Architecture, Manage network resources, create external/public networks, create project networks, create project routers, attach routers to public and project networks, manage network services for a virtual environment, manage network quotas, manage network interfaces on compute instances, create and manage project security groups and rules, assign security group to instance, create and manage floating IP addresses, assign floating IP address to instance, detach floating IP address from instance. Identity and access management- keystone: users, roles, groups.

Theory:30		Tutorial:0	Practical:30	Project:0	Total:60 Hours

.

REFERENCES

1. Ben Silverman, Michael Solberg, "OpenStack for Architects :Design Production-ready Private Cloud Infrastructure", 2nd Edition, Packt Publishing, 2018.
2. Michael Solberg, Ben Silverman, "OpenStack for Architects" , Packt Publishing,· 2017
3. Alok Shrivastwa, Sunil Sarat, Kevin Jackson, Cody Bunch, Egle Sigler, Tony Campbell, "OpenStack: Building a Cloud Environment", Packt Publishing, 2016
4. James Denton, "Learning OpenStack Networking (Neutron)", Packt Publishing, 2015.

ONLINE LEARNING MATERIALS

1. https://www.coursera.org/learn/juniper-openstack-and-kubernetes?

LAB CONTENT

Deployment of OpenStack components.

Sample Exercises:
1. Configure NOVA compute Node
2. Configure Swift object storage
3. Construct a cinder block node
4. Build a horizon node – Monitor node
5. Launching an instance- Register an account at openstack, Create SSH Key, validate network.
6. Sharing project environment among multiple users.

`

		L	T	P	J	C
P20CAE0249	**CLOUD STORAGE MANAGEMENT**	2	0	2	0	3

COURSEOUTCOMES

After successful completion of this course, the students should be able to

CO1: Make use of cloud storage technologies in applications. (K3)

CO2: Correlate different storage networking technologies. (K3)

CO3: Make use of the design principles of virtualization techniques in cloud resource management. (K3)

CO4: Analyze different cloud storage life cycle strategies. (K4)

CO5: Select appropriate backup and recovery strategies.(K3)

Prerequisite: P20CAE0247 - Virtualization and Resource Management

COs	CO/PO MAPPING (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak											
	PROGRAMME OUTCOMES (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S							M		M	M	
CO2	M	M	M				M		M			
CO3	M	S	S							M		
CO4	M				M							
CO5	M	M										

THEORY COMPONENT CONTENTS\

INTRODUCTION TO CLOUD STORAGE   7 Hours

Overview of cloud storage concepts - Advantages and challenges of cloud storage - Comparison of traditional storage vs. cloud storage, Evolution of Storage Architecture, Data Center Infrastructure, Storage Technologies **:** Block, file, and object storage - Storage protocols (iSCSI, NFS, SMB, etc.) - Data replication, snapshots, and backups in the cloud.

STORAGE NETWORKING TECHNOLOGIES   8 Hours

Network-Attached Storage: General-Purpose Servers versus NAS Devices, Benefits of NAS, File Systems and Network File Sharing, Components of NAS, NAS I/O Operation, NAS Implementations, NAS File-Sharing Protocols, Factors Affecting NAS Performance, File-Level Virtualization. Fibre Channel Storage Area Networks: Fibre Channel Overview, The SAN and Its Evolution, Components of FC SAN, FC Connectivity, Switched Fabric Ports, Fibre Channel Architecture, Fabric Services, Switched Fabric Login Types, Zoning, FC SAN Topologies, Virtualization in SAN. IP SAN and FCoE: iSCSI, FCIP, FCoE

LIFE CYCLE MANAGEMENT AND SECURITY   8 Hours

Introduction to storage tiers**,** Different Storage Classes Offered by Cloud Providers - Choosing the Right Storage Class for Different Use Cases - Access Control and Security - Identity and Access Management (IAM) - Encryption in Transit and at Rest

`

BACKUP AND DISASTER RECOVERY **7 Hours**

Introduction to Business Continuity: Information Availability, BC Terminology, BC Planning Life Cycle, Failure Analysis, Business Impact Analysis, BC Technology Solutions. Backup and Archive: Backup Purpose, Backup Considerations, Backup Granularity, Recovery Considerations, Backup Methods, Backup Architecture, Backup and Restore Operations, Backup, Backup in NAS Environments, Backup Targets, Data Deduplication for Backup, Backup in Virtualized Environments, Data Archive, Archiving Solution Architecture

REFERENCES

1. Data Intensive Storage Services for Cloud Environments by Athanasios Voulodimos, Dimosthenis P. Kyriazis, Spyridon V. Gogouvitis, Theodora Varvarigou, Business Science Reference, 2013.
2. Cloud Storage Management in Contemporary IT Environments by Michael O'Dell and Michael Corey, Packt Publishing, 2012.
3. Borko Furht, Armando Escalante Handbook of Cloud Computing, Springer Science+Business Media, LLC 2010
4. Information Storage and Management by Emc Education S, John Wiley & Sons, Incorporated, 2012.

ONLINE LEARNING MATERIALS

1. https://www.coursera.org/learn/data-storage-microsoft-azure
2. https://www.udemy.com/course/introduction-to-cloud-storage-apps-a-beginners-course/
3. https://www.coursera.org/learn/cloud-storage-big-data-analysis-sql
4. https://www.classcentral.com/course/linkedin-learning-learning-cloud-computing-cloud-storage-30444

LAB CONTENTS

Attaching volume to instances, Creating snapshots from volumes, Migrating a file among different storage classes, Managing access control over a file/storage, Enabling client and server-side encryption for an object.

Sample Exercise:
1. Attaching volume to instances.
2. Creating snapshots for volumes.
3. Migrating a file among different storage classes.
4. Managing access control over a file/storage.
5. Enabling client and server-side encryption for an object.

Theory:30	Tutorial:0	Practical:30	Project:0	Total:60 Hours

L	T	P	J	C
2	0	2	0	3

P20CAE0250   CLOUD SECURITY

COURSE OUTCOMES
After successful completion of this course, the students should be able to

CO1: Analyze the security breaches of IaaS, PaaS and SaaS. (K4)
CO2: Apply various data encryption methods and security mechanisms to get the administrative
control using IAM service. (K3)
CO3: Inspect compliance, governance and risk management (K4)
CO4: Make use of CI/CD pipeline in application security (K3).
CO5: Analyze security in edge computing (k4)

Pre-requisite: P20CAE0247 - Virtualization and Resource Management

COs	CO/PO MAPPING (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak											
	PROGRAMME OUTCOMES (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1				M								M
CO2			M				M			M		
CO3					S	M				M		
CO4		S		M								
CO5		M			M							

THEORY COMPONENT CONTENT

INTRODUCTION TO CLOUD SECURITY   6 Hours
Overview of cloud computing and its security challenges - Importance of cloud security for organizations
- Shared responsibility model in cloud security. Cloud Service Models and Security**:** Security
considerations for IaaS, PaaS, and SaaS, Risks and security measures specific to each service model,
Case studies highlighting security vulnerabilities in cloud services.

CLOUD SECURITY ARCHITECTURE AND DATA PROTECTION   6 Hours
Designing secure cloud architectures, Identity and access management (IAM) in the cloud Network
security in a cloud environment. Encryption techniques for data at rest and in transit Key management
best practices, Data loss prevention (DLP) strategies in the cloud

COMPLIANCE, GOVERNANCE, AND RISK MANAGEMENT   6 Hours
Compliance requirements in the cloud (e.g., GDPR, HIPAA), Risk assessment and management in cloud
environments, Implementing governance frameworks for cloud security, Cloud-specific threats and
vulnerabilities, Security monitoring and logging in the cloud, Incident response planning and execution
in cloud environments.

SECURE DEVELOPMENT AND DEVSECOPS   6 Hours
Security considerations in cloud-native application development, Implementing security in CI/CD

pipelines, Best practices for DevSecOps in the cloud.

EMERGING TRENDS AND FUTURE OF CLOUD SECURITY   **6 Hours**
Edge computing and its security implications, Zero-trust security models in the cloud, Future directions and trends in cloud security

REFERENCES
1. Cloud Security Attacks, Techniques, Tools and Challenges by Preeti Mishra, Emmanuel S Pilli, R C Joshi · 2021
2. Cloud Security: Concepts, Applications and Perspectives by Brij B. Gupta · 2021.
3. Securing the Cloud: Cloud Computer Security Techniques and Tactics by Vic (J.R.) Winkler
4. Cloud Security: A Comprehensive Guide to Secure Cloud Computing by Ronald L. Krutz, Russell Dean Vines · 2010
5. Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance (Theory in Practice) 1st Edition, by Tim Mather (Author), Subra Kumaraswamy (Author), Shahed Latif (Author) 2009.

ONLINE LEARNING MATERIALS
1. https://www.coursera.org/learn/cloud-security-basics
2. https://www.coursera.org/learn/sscp-4th-ed-course-6
3. https://www.coursera.org/learn/cloud-data-security
4. https://www.checkpoint.com/cyber-hub/cloud-security/what-is-cloud-security/
5. https://www.zscaler.com/resources/security-terms-glossary/what-is-cloud-security
6. https://medium.com/@goodycyb/exploring-cloud-security-in-depth-labs-and-insights-for-aws-and-gcp-50ca038478c4
7. https://goodycyb.hashnode.dev/

LAB CONTENTS
    Securing Free tier account, IAM, account bills, instances within Virtual Private Cloud, Role based access control with cloud platform IAM, Instance with firewall rules , Data encryption and decryption using cloud platforms, restricting access to storage, Configuring networking firewall for an application

`

Sample exercises:
1. Securing free tier account in cloud platform
2. Securing free tier account in cloud platform with IAM user
3. Creating IAM role, Group.
4. Securing free tier account setting billing in cloud platform
5. Securing instances in cloud platform within Virtual Private Cloud
6. Implementing role based access control with cloud platform IAM
7. Securing instances with firewall rules
8. Data encryption and decryption using cloud platforms
9. Securing and restricting access to storage
10. Configuring networking firewall for an application

| Theory:30 | Tutorial:0 | Practical:30 | Project:0 | Total:60 Hours |

`

	L	T	P	J	C
	2	0	0	2	3

P20CAE0351   **CLOUD AUTOMATION**

<u>**COURSEOUTCOMES**</u>
After successful completion of this course, the students should be able to
CO1:   Identify appropriate cloud automation tools for an application. (K3)
CO2:   Take part in automating DevOps using tools. (K4)
CO3:   Make use of storage automation in an application. (K3)
CO4:   Apply automation tools in monitoring services. (K3)
CO5:   Utilize tools for the cloud resource scaling and management. (K3)

Prerequisite: P20CAE0247 - Virtualization and Resource Management

COs	CO/PO MAPPING (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak											
	PROGRAMME OUTCOMES (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	M		M	M				M	M		
CO2	M							M			M	
CO3	S	S					M					
CO4	M				M							
CO5	M	S			M			M				

THEORY COMPONENT CONTENT

INTRODUCTION CLOUD AUTOMATION   **7 Hours**
Benefits of cloud automation - Types of cloud automation tools - Use cases for cloud automation.
Managing and provisioning infrastructure through code (using tools like Terraform, Ansible, Puppet,
Chef), Automating code integration and verification through tools like Jenkins, GitLab CI, or CircleCI,
Automating the deployment process to push code changes into production environments reliably.

CLOUD RESOURCE SCALLING AND STORAGE AUTOMATION   **8 Hours**
Automating resource allocation, de-allocation, and right-sizing of resources based on usage.
Kubernetes - Salt -CircleCI - Ansible and puppet, AWS DataSync, Azure Data Factory.

CLOUD AUTOMATION TOOLS FOR DEVOPS   **7 Hours**
DuploCloud - Puppet - Heroku -HashiCorp, Monitoring and Logging Tools – Prometheus, Grafana,
Docker, Raygun, Splunk, Git, Ansible, Jenkins, Bamboo.

CLOUD DEPLOYMENT AUTOMATION   **8 Hours**
NetApp Cloud Volumes ONTAP - CFEngine -VMware vs Realize Automation - Cisco Intelligent -
Automation for Cloud - Microsoft Azure Automation - Google Cloud Deployment Manager - AWS
CloudFormation - IBM Cloud Schematics

`

REFERENCES

1.Mikael Krief,, "Learning DevOps: The complete guide to accelerate collaboration with Jenkins, Kubernetes, Terraform and Azure DevOps",Packt Publishing; 1st edition, 2019.

2.Marcelo Pinheiro, "Mastering DevOps Automation", Packt Publishing Limited, 2018.

3.Jeff Geerling, "Ansible for DevOps: Server and Configuration Management for Humans", Midwestern Mac, LLC; 1st edition, 2015.

4.John Rhoton and James Stanger, "Cloud Automation and DevOps: Transforming Your IT Environment:, 2015.

ONLINE LEARNING MATERIALS

1. https://www.coursera.org/learn/automation-in-aws
2. https://www.coursera.org/learn/gcp-infrastructure-scaling-automation
3. https://www.udemy.com/course/aws-cloud-security-proactive-way/
4. https://www.edx.org/learn/computer-programming/google-cloud-elastic-google-cloud-infrastructure-scaling-and-automation

PROJECT

Projects involving different cloud platform services like Puppet, Heroku, HashiCorp and monitoring & Logging Tools – Prometheus, Grafana, Docker, Raygun, Splunk, Git, Ansible, Jenkins, Bamboo.

Theory:30	Tutorial:0	Practical:0	Project: 30	Total:60 Hours

`

P20CAE0252   **FULLSTACK SOFTWARE DEVELOPMENT**

L	T	P	J	C
2	0	2	0	3

<u>COURSEOUTCOMES</u>
After successful completion of this course, the students should be able to
CO1: Create a Web Server with Node.js for a simple application. (K3)
CO2: Develop a Web Application in Express.js Framework. (K3)
CO3: Build an application with Node.js and MongoDB. (K3)
CO4: Deploy the developed application in GitHub repository. (K3)

Prerequisite: NIL

COs	CO/PO MAPPING (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak											
	PROGRAMME OUTCOMES (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	M	M		S		M	M				
CO2	S	M	M		S		M	M				
CO3	S	M	M		S		M	M				
CO4					S	M	M	M	M	M	M	

THEORY COMPONENT CONTENT

INTRODUCTION TO FULLSTACK DEVELOPMENT& VERSION CONTROL   6 Hours
Overview of HTML, CSS, JavaScript, and Bootstrap.
Web Development Stack-Full Stack–Introduction–Types: MERN, MEAN, MEVN,LAMP, Ruby on Rails, Django, NET, JAMSTACK
Version Control–Need-Popular version control tools like Git-create a GitHub account-Use the GitHub web interface to create a repository-add a file to Git and commit the changes–Git commands.

INTRODUCTION TO NODE.JS   6 Hours
Introduction to Node.js - Server-Side JavaScript and Node.js - Creating a Web Server with Node.js - Working with Node.js Modules - Overview of Node Package Manager

SERVER-SIDE JAVASCRIPT   6 Hours
Asynchronous I/O with Callback Programming - Creating Callback Functions - Using Anonymous Callback Functions in Node.js - Issues with Callbacks - Working with JSON – Handling errors and debugging Node.js applications.

EXPRESS WEB APPLICATION FRAMEWORK   6 Hours
Extending Node.js - Working with Third Party Node.js Extensions - Introduction to Web Frameworks - Express Web Application Framework - Working with Back-end JavaScript Frameworks and Express -Routing, Middleware, and Templating-Authentication in Node JS - Middleware & Routers-HTTP Methods and Rest APIs.

MONGODB AND DEPLOYMENT OF NODE.JS APPLICATIONS   6 Hours
NoSQL databases and MongoDB - Setting up a MongoDB development environment – Building

`

MongoDB schema and models with Mongoose–Connecting Node.js application with MongoDB – Testing and Deploying Node.js applications with server configurations.

LAB CONTENTS
Sample List of Lab Experiments:
1. Create your own Node.js module and import and use modules in your webserver application.
2. Develop asynchronous functions with callbacks, error handling, a n d control flow using callbacks.
3. Demonstrate JSON file data read and write usingNode.js.
4. Create a RESTful API to serve JSON data.
5. Demonstrate RESTful endpoints using Express and HTTP methods to handle GET, POST, PUT, and DELETE requests.
6. Integrate a template engine(e.g., EJS or Pug)with Express and Render dynamic HTML views using templates.
7. Implement user authentication in your Express application.
8. Exploreandintegratethird-partyNode.jsextensionsintoyourExpressappandshowcase the benefits of using extensions for specific features.
9. Create a multi-page web application with authentication, routing, and RESTfulAPIs.
10. Create a simple Employee Management ApplicationwithMongoDBandNode.js.

Theory:30	Tutorial:0	Practical: 30	Project:0	Total:60 Hours

REFERENCES
1. "Mastering HTML, CSS & JavaScript Web Publishing" by Laura Lemay, Rafe Colburn, Jennifer Kyrnin, BPB Publications, 2016.
2. "Node.js Web Development: Server-side web development" by David Herron, 5th Edition, 2020
3. "Node.js in Action" byAlex Young, Bradley Meck, Mike Cantelon, TimOxley, Marc Harter, T.J. Holoway chuk, and Nathan Rajlich, Manning, 2nd Edition, 2017
4. "Node.js Design Patterns" by Luciano Mammino and Mario Casciaro,3rd Edition, 2022.
5. 5."Web Development with MongoDB and NodeJS" by Mithun Satheesh, Bruno Joseph D'mello, Jason Krol, Packt Publishing Limited; 2nd edition, 2015.
6. "Web Development with Node and Express" by Ethan Brown, O'Reilly Media, Inc.2nd Edition, 2019.
7. "Pro Git" by Scott Chacon, Ben Straub, Apress, 2nd edition, 2014.

ONLINE LEARNING MATERIALS
1. Introduction to Web Development with HTML, CSS, JavaScript | Coursera
2. Getting Started with Git and GitHub| Coursera
3. Developing Back-End Apps with Node.js and Express | Coursera
4. Introduction to MongoDB | Coursera
5. [Project]BuildaCRUDNode.js and MongoDB employee management web-app|Coursera

OTHER ELECTIVES

P20CAE0001	INFORMATION SECURITY	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Understand the basic concepts of information security, its model and development life cycle.

CO2: Assess the need for information security and its legal, ethical and its professional issues.

CO3: Identify the information security needs.

CO4: Enable planning of security solutions.

CO5: Implement and practice security policies.

Pre–requisite courses:

P20CAT2004 Data Communications and Networks.

Cos	PROGRAMME OUTCOMES (POs) (S/M/W Indicates Strength of Correlation) S-Strong, M-Medium, W- Weak											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M									W		
CO2		S				S						
CO3		M					M			M		
CO4	M	M	W			M						
CO5		M	M			M						

COURSE ASSESSMENT METHODS
DIRECT
1. Continuous Assessment Test I, II
2. Assignment; Group Presentation
3. End Semester Examination
INDIRECT
1. Course-end survey

INFORMATION SECURITY (IS)	9 Hours

Introduction – History – Security – Critical Characteristics of Information – National Security Telecommunications and Information System Security Committee (NSTISSC) – Security Model – Components of an Information System – Securing the Components – Balancing Information Security and Access – The Systems Development Life Cycle – Security Professionals and the Organization.

SECURITY INVESTIGATION	9 Hours

Need for Security – Business Needs – Threats – Attacks – Legal, Ethical and Professional Issues in Information Security – Selecting Risk Control Strategy – Risk Management – Recommended Risk Control Practices.

SECURITY PLANNING	9 Hours

Information Security Policy, Standards and Practices – Information Security Blueprint – Design of Security Architecture – Security Education – Training and Awareness Program – Continuity Strategies.

SECURITY TECHNOLOGY	9Hours

Physical Design – Firewalls – Protecting Remote Connections – Intrusion Detection and Prevention Systems – Honey Pots, Honey Nets, Padded Cell Systems – Scanning and Analysis Tools – Access Control Devices.

IMPLEMENTATION	6 Hours

Implementing IS – IS Project Management – Technical and Non Technical Aspects of Implementation - Security and Personnel – Introduction – Positioning and Staffing the Security Function – Credentials of IS Professionals – Employment Policies and Practices – Internal Control Strategies – Privacy and the Security of Personal Data.

MAINTENANCE	3 Hours

Information Security Maintenance – Security Management Models – Maintenance Model – Digital Forensics.

Theory: 45	Tutorial: Nil	Total : 45 Hours

REFERENCES

1. Michael E Whitman and Herbert J Mattord, "Principles and Practices of Information Security", Cengage Learning, 2018.
2. Charles P. Pfleeger and Shari Lawrence Pfleeger, "Security in Computing" Pearson Education Pvt. Ltd., 2015.
3. Matt Bishop, "Computer Security Art and Science", Pearson/PHI, 2010.

P20CAE0002	**OBJECT ORIENTED ANALYSIS AND DESIGN**	**L**	**T**	**P**	**J**	**C**
		3	**0**	**0**	**0**	**3**

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Understand the basic concepts to identify state and behavior of real world objects.

CO2: Apply the various object oriented methodologies and choose the appropriate one for solving
   the problem with the help of various case studies.

CO 3: Understand the concept of analysis, design and testing to develop a document for the project.

CO 4: Implement analysis, design and testing phases in developing a project using object orientation.CO
5: Understand and apply testing techniques for object oriented software.

Pre–requisite :Nil

Cos	**PROGRAMME OUTCOMES (POs)**											
	(S/M/W Indicates Strength of Correlation) S-Strong, M-Medium, W- Weak											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	M	W										
CO2	M	M	W	W								
CO3	S	S	M	W							W	
CO4	S	M	W							W		
CO5	M		S									

COURSE ASSESSMENT METHODS
DIRECT
1.Continuous Assessment Test I, II
2.Assignment; Group Presentation
3.End Semester Examination
INDIRECT
1.Course-end survey

INTRODUCTION	**6 Hours**

An Overview – Object Basics – Object State and Properties – Behavior – Methods – Messages –
Information Hiding – Class Hierarchy – Relationships – Associations – Aggregations – Identity – Dynamic
Binding – Persistence – Meta Classes – Object Oriented System Development Life Cycle.

METHODOLOGY AND UML	**12 Hours**

Introduction – Survey – Rumbaugh, Booch and Jacobson Methodologies – Unified Approach – Unified
Modeling Language – UML Diagrams – Class Modeling – State Modeling – Interaction Modeling –
Introduction to Patterns and Frameworks.

OBJECT ORIENTED ANALYSIS	9 Hours

Identifying Use Case – Business Object Analysis – Use Case Driven Object Oriented Analysis – Use Case Model – Documentation – Classification – Identifying Object, Relationships, Attributes, Methods – Super – Sub Class – A–Part–of Relationships, Identifying Attributes and Methods – Object Responsibility.

OBJECT ORIENTED DESIGN	7 Hours

Design Process and Benchmarking – Axioms – Corollaries – Designing Classes – Class Visibility – Refining Attributes – Methods and Protocols – Object Storage and Object Interoperability – MVC Architectural Pattern and Design – Designing the System.

ACCESS LAYER	3 Hours

Object Persistence – Object Oriented Database Management Systems – Object Relational Systems – Multi Database Systems – Designing Access Layer Classes

VIEW LAYER	3 Hours

User Interface Design – Designing View Layer Classes – Macro Level Process – Micro Level Process – The purpose of a View Layer Interface.

SOFTWARE QUALITY ASSURANCE AND TESTING	5 Hours

Testing Strategies – Impact of Object Orientation on Testing – Test Cases – Test Plan – Usability Testing – User Satisfaction Testing.

Theory: 45	Tutorial: -	Total : 45 Hours

REFERENCES

1. Ali Bahrami, "Object Oriented System Development", McGraw Hill International Edition, 2017.
2. Michael R Blaha and James R Rumbaugh, "Object Oriented Modeling and Design with UML", 2nd Edition, Pearson, 2011.
3. Craig Larman, "Applying UML and Patterns", 2nd Edition, Pearson, 2002.
4. Brahma Dathan and Sarnath Ramnath, "Object–Oriented Analysis, Design and Implementation", Universities Press, 2010.
5. Grady Booch, James Rumbaugh and Ivar Jacobson, "The Unified Modeling Language User Guide", Pearson Education INC, 2009.

P20CAE0003	GAME DEVELOPMENT	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Understand the concepts of Game design and development.

CO2: Analyze the processes, mechanics and issues in Game Design.

CO3: Be exposed to the Core architectures of Game Programming.

CO4: Know about Game programming platforms, frame works and engines.

CO5: Design and develop games

Pre–requisite : Nil

Cos	PROGRAMME OUTCOMES (POs) (S/M/W Indicates Strength of Correlation) S-Strong, M-Medium, W- Weak											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S		M									
CO2		S	M									
CO3										W		M
CO4		S					M					
CO5	S		M		M							

COURSE ASSESSMENT METHODS

DIRECT

1. Continuous Assessment Test I, II

2. Assignment; Group Presentation

3. End Semester Examination

INDIRECT

1. Course-end survey

3D GRAPHICS FOR GAME PROGRAMMING	**9 hours**

3D Transformations – Quaternions - 3D Modeling and Rendering - Ray Tracing - Shader Models – Lighting – Color – Texturing - Camera and Projections - Culling and Clipping - Character Animation - Physics-based Simulation - Scene Graphs.

GAME ENGINE DESIGN	**9 hours**

Game Engine Architecture - Engine Support Systems - Resources and File Systems - Game Loop and Real-Time Simulation - Human Interface Devices - Collision and Rigid Body Dynamics - Game Profiling.

GAME PROGRAMMING	**9 hours**

Application Layer - Game Logic - Game Views - Managing Memory - Controlling the Main Loop - Loading and Caching Game Data - User Interface Management - Game Event Management.

GAMING PLATFORMS AND FRAMEWORKS	9 hours
2D and 3D Game Development using Flash, DirectX, Java, Python - Game development with PyGame- Game engines – DX Studio - Unity.	

GAME DEVELOPMENT	9 hours
Developing 2D and 3D interactive games using DirectX or Python – Isometric and Tile Based Games - Puzzle games - Single Player games - Multi-Player games.	

Theory: 45 Hours	Tutorial: Nil	Total : 45 Hours

REFERENCES

1. Mike McShaffrfy and David Graham, "Game Coding Complete", Fourth Edition, Cengage Learning, PTR, 2012.
2. Jason Gregory, "Game Engine Architecture", Third Edition, CRC Press, 2019.
3. David H. Eberly, "3D Game Engine Design, Second Edition: A Practical Approach to Real-Time Computer Graphics" 2nd Editions, Morgan Kaufmann, 2006.
4. Ernest Adams and Andrew Rollings, "Fundamentals of Game Design", 2nd Edition Prentice Hall / New Riders, 2009.
5. Eric Lengyel, "Mathematics for 3D Game Programming and Computer Graphics", 3rd Edition, Course Technology PTR, 2011.
6. Jesse Schell, The Art of Game Design: A book of lenses, 1st Edition, CRC Press, 2008.

P20CAE0004	SOFTWARE PROJECT MANAGEMENT	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Understand the principles and techniques of software project management.

CO2: Describe and apply the evaluation and estimation techniques.

CO3: Perform planning, resource allocation and risks.

CO4: Understand about monitoring and controlling of projects.

CO5: Explain how to manage contracts and people.

Pre–requisite: P20CAT2001- Software Engineering Methodologies and Quality Assurance

Cos	PROGRAMME OUTCOMES (POs) (S/M/L Indicates Strength of Correlation) S-Strong, M-Medium, L- Less											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	W							M			M	
CO2	M	M	S		W							
CO3		S	W	W	W						M	
CO4	S	M	M	W								
CO5							W		M	W		

COURSE ASSESSMENT METHODS

DIRECT

1. Continuous Assessment Test I, II
2. Assignment; Group Presentation
3. End Semester Examination

INDIRECT

1. Course-end survey

INTRODUCTION	5 Hours

Software Project Definition – Need for Software Project Management – Software Projects versus Other Types of Projects – Activities Covered by Software Project Management – Categories of Software Projects – An Overview of Project Planning.

PROJECT EVALUATION AND APPROACH	7 Hours

Strategic and Technical Assessment – Cost Benefit Analysis and Evaluation – Risk Evaluation - Selection of an Appropriate Project Approach.

SOFTWARE EFFORT ESTIMATION	8 Hours

Software Effort Estimation – Basics – Effort Estimation Techniques – Top Down and Bottom Up Estimating Approaches – Function Point Analysis – COCOMO Models.

ACTIVITY PLANNING	7 Hours
Activity Planning – Objectives – Project Schedules – Sequencing and Scheduling Activities – Network Planning Models – Formulation of a Network Model – Forward Pass – Backward Pass – Critical Path – Activity Float – Shortening Project Duration – Activity on Arrow Networks.	

RISK MANAGEMENT	3 Hours
Nature and Types of Risk – Managing Risk – Risk planning and control.	

RESOURCE ALLOCATION	5 Hours
Resource Allocation – Nature of Resources – Identifying Resources – Scheduling Resources – Creating Critical Paths – Cost Schedules.	

MONITORING AND CONTROL	5 Hours
Monitoring and Control – Creating Framework – Collecting the Data – Visualizing Progress – Cost Monitoring.	

MANAGING CONTRACTSAND PEOPLE	5 Hours
Managing Contracts – Types of Contracts – Stages in Contract Placement – Organizational Behavior- Selecting the Right Person – Motivation.	
Theory: 45 Hours **Tutorial: Nil** **Total : 45 Hours**	

REFERENCES

1. Bob Hughes, Mike Cotterell and Rajib Mall, "Software Project Management", Sixth edition, McGraw Hill, 2017.
2. Pankaj Jalote, "Software Project Management in Practice", Pearson, 2016.
3. Robert.T.Futrell, Donald F.Shafer and Linda I.Shafer, "Quality Software Project Management", Pearson Education, Asia, 2002.

P20CAE0005	E-COMMERCE	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO 1: Understand the differences between E–Commerce and traditional commerce.

CO 2: Analyse the legal, ethical and social issues of E-Commerce.

CO 3: Understand the selling and marketing on web.

CO 4: Analyse the features of Business to business activities.

CO 5: Understand the current technological advancements in E-commerce.

Pre–requisite : Nil

Cos	PROGRAMME OUTCOMES (POs) (S/M/W Indicates Strength of Correlation) S-Strong, M-Medium, W- Weak											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M									S		
CO2		M				S				M		
CO3	M						M			S		
CO4	M						M					
CO5	S		S		M		M				W	

COURSE ASSESSMENT METHODS

DIRECT

1. Continuous Assessment Test I, II
2. Assignment; Group Presentation
3. End Semester Examination

INDIRECT

1. Course-end survey

INTRODUCTION	5 Hours

Introduction to Electronic Commerce: The Evolution of Electronic Commerce – Business Models – Revenue Models and Business Processes – Economic Forces and Electronic Commerce– Identifying Electronic Commerce Opportunities – International Nature of Electronic Commerce.

ENVIRONMENT OF ELECTRONIC COMMERCE	4 Hours

Legal, Ethical, and Tax Issues: The Legal Environment of Electronic Commerce – Use and Protection of Intellectual Property in Online Business – Online Crime, Terrorism and Welfare – Ethical Issues – Taxation and Electronic Commerce.

COMMERCE ON WEB	9 Hours
Selling on the Web: Revenue Models for Online Business - Changing Strategies: Revenue Models in Transition - Revenue Strategy Issues for Online Businesses - Creating an Effective Business Presence Online - Web Site Usability -Using the Web to Connect with Customers. Marketing on the Web: Web Marketing Strategies – Communicating with Different Market Segments – Beyond Market Segmentation: Customer Behavior and Relationship Intensity – Advertising on the Web – E–Mail Marketing – Technology Enabled Customer Relationship Management – Creating and Maintaining Brands on the Web – Search Engine Positioning and Domain Names.	

BUSINESS ACTIVITIES	9 Hours
Business-to-Business Activities: Improving Efficiency and Reducing Costs – Introduction - Purchasing, Logistics, and Business Support Processes - Electronic Data Interchange - Supply Chain Management Using Internet Technologies - Online Business Marketplaces and Networks. Social Networking, Mobile Commerce, and Online Auctions – Introduction - From Virtual Communities to Social Networks - Mobile Commerce - Online Auctions.	

SECURITY	5 Hours
Electronic Commerce Security: Online Security Issues Overview – Security for Client Devices– Communication Channel Security – Security for Server Computers – Organizations that Promote Computer Security.	

WEB SERVER HARDWARE AND SOFTWARE	4 Hours
Web Server Basics – Software for Web Servers – Electronic Mail – Web Site Utility Programs – Web Server Hardware	

PAYMENT SYSTEMS	9 Hours
Common Online Payment Methods - Payment Cards - Digital Cash - Digital Wallets - Internet Technologies and the Banking Industry - Payment System Threats: Phishing and Identity Theft. Case Studies: E–Commerce Web Sites.	
Theory: 45Tutorial: - **Total: 45 Hours**	

REFERENCES

1. Gary P.Schneider, "Electronic Commerce", 12th Edition, Cengage Learning India Private Limited, New Delhi, 2017.
2. Kenneth C.Laudon & Carol Guercio Traver, "E–Commerce – Business, Technology & Society", Pearson Education, 2008.
3. Dave Chaffey, "E–Business and E–Commerce Management", 4th Edition, Pearson Education, 2011.

P20CAE0006	TCP/IPV6 PROTOCOL SUITE	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Understand the implementation of various standards in the network protocols.

CO2: Interact with the network utilities.

CO3: Know the design aspects involved in the protocols of the TCP/IP protocol suite.

CO4: Design, implement, configure and manage a computer network.

CO5: Understand the functionality of the process in the protocol suite

Pre–requisite : Nil

Cos	PROGRAMME OUTCOMES (POs) (S/M/W Indicates Strength of Correlation) S-Strong, M-Medium, W- Weak											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	S					S					
CO2		S	M		M							
CO3	M	S		M	S		S					
CO4	M			M								
CO5	M		M									

COURSE ASSESSMENT METHODS

DIRECT

    1.Continuous Assessment Test I, II

    2.Assignment; Group Presentation

    3.End Semester Examination

INDIRECT

    1.Course-end survey

INTRODUCTION	10 Hours

Standards – Internet – OSI Model – TCP/IP Protocol suite – Addressing – Wired Local Area Networks – Wireless Local Area Networks – Connecting Devices.

INTERNET PROTOCOL	10 Hours

IP addressing – Introduction – Classful Addressing – Classless Addressing – Special Address – NAT IP Packets – Delivery – Forwarding – Structure of Router – IPv4 Introduction – Datagram – Fragmentation – Checksum – IP Package – Address Resolution Protocol (ARP) – Internet Control Message Protocol (ICMP) – Internet Protocol Version 6 (IPV6) Addressing – IPV6 Protocol.

TRANSPORT PROTOCOL	8 Hours

User Datagram Protocol (UDP) – UDP Applications – UDP Package – UDP Design – Transmission Control Protocol (TCP) Services – TCP Features – Segment – Connection – State Transition Diagram – Windows in TCP – Flow Control – Error Control – Congestion Control.

APPLICATION LAYER AND CLIENT SERVER MODEL	8 Hours

Client Server Paradigm – Dynamic Host Configuration Protocol(DHCP) – DHCP Operation – DHCP Configuration – Domain Name System (DNS) – Name Space – DNS in the Internet – Resolution – DNS Message – Types of Records – TELNET.

APPLICATION PROTOCOLS	9 Hours

File Transfer Protocol (FTP) – Connections – Communication – World Wide Web and Hypertext Transfer Protocol (HTTP) – Electronic Mail – Simple Network Management Protocol (SNMP) – Management Components – Structure Management Information (SMI) – Management Information Base (MIB).

Theory: 45Tutorial: -   Total Hours: 45 Hours

REFERENCES

1. Behrouz A. Forouzan, "TCP/IP Protocol Suite", 4th Edition, Tata McGraw Hill, 2017.
2. Douglas E. Comer & David L. Stevens, "Internetworking with TCP/IP –Volume I, II and III", 5th Edition, Prentice–Hall of India Pvt. Ltd., 2005.

P20CAE0007	WIRELESS NETWORKS	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO 1: Explain about wireless networks, protocol stack and standards.

CO 2: Conversant with the latest 3G/4G and WiMAX networks and its architecture.

CO 3: Design and implement wireless network environment for any application using latest wireless protocols and standards.

CO 4: Describe the platform architectures that are suitable for mobile computing and communications.

CO 5: Implement different type of applications for smart phones and mobile devices with latest network strategies.

CO 6: Understand various security threats and describe proposed solutions.

Pre–requisite : Nil

Cos	PROGRAMME OUTCOMES (POs) (S/M/W Indicates Strength of Correlation) S-Strong, M-Medium, W- Weak											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S											
CO2									M			
CO3		S	M									M
CO4												M
CO5	S		M		M					W		
CO6		S		M								

COURSE ASSESSMENT METHODS
DIRECT
1. Continuous Assessment Test I, II
2. Assignment; Group Presentation
3. End Semester Examination
INDIRECT
1. Course-end survey

WIRELESS LAN	9 Hours

Introduction-WLAN technologies: Infrared, UHF narrowband, spread spectrum -IEEE802.11: System architecture, protocol architecture, physical layer, MAC layer, 802.11b, 802.11a – Hiper LAN: WATM,BRAN, HiperLAN2 – Bluetooth: Architecture, Radio Layer, Baseband layer, Link manager Protocol, security - IEEE802.16-WIMAX: Physical layer, MAC, Spectrum allocation for WIMAX

MOBILE NETWORK LAYER	9 Hours

Introduction - Mobile IP: IP packet delivery, Agent discovery, tunneling and encapsulation, IPV6-Network layer in the internet- Mobile IP session initiation protocol - mobile ad-hoc network: Routing, Destination Sequence distance vector, Dynamic source routing.

MOBILE TRANSPORT LAYER	9 Hours

TCP enhancements for wireless protocols - Traditional TCP: Congestion control, fast retransmit/fast recovery, Implications of mobility - Classical TCP improvements: Indirect TCP, Snooping TCP, Mobile TCP, Time out freezing, Selective retransmission, Transaction oriented TCP - TCP over 3G wireless networks.

WIRELESS WIDE AREA NETWORK	9 Hours

Overview of UTMS Terrestrial Radio access network-UMTS Core network Architecture: 3G-MSC, 3GSGSN, 3G-GGSN, SMS-GMSC/SMS-IWMSC, Firewall, DNS/DHCP-High speed Downlink packet access (HSDPA)- LTE network architecture and protocol.

4G NETWORKS	9 Hours

Introduction – 4G vision – 4G features and challenges - Applications of 4G – 4G Technologies: Multicarrier Modulation, Smart antenna techniques, OFDM-MIMO systems, Adaptive Modulation and coding with time slot scheduler, Cognitive Radio.

Theory: 45 Hours   **Tutorial: -   Total : 45 Hours**

REFERENCES

1. Jochen Schiller, "Mobile Communications", Second Edition, Pearson Education 2012.
2. Vijay Garg , "Wireless Communications and networking", First Edition, Elsevier 2007.
3. Erik Dahlman, Stefan Parkvall, Johan Skold and Per Beming, "3G Evolution HSPA and LTE for Mobile Broadband", Second Edition, Academic Press, 2008.
4. Anurag Kumar, D.Manjunath, Joy kuri, "Wireless Networking", First Edition, Elsevier 2011.
5. Simon Haykin , Michael Moher, David Koilpillai, "Modern Wireless Communications", First Edition, Pearson Education 2013.

P20CAE0008	BLOCKCHAIN TECHNOLOGIES	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Understand the technology components of Blockchain and how it works behind the scenes.

CO2: Be aware of different approaches to developing decentralized applications.

CO3: Understand the Bitcoin and its limitations by comparing with other alternative coins.

CO4: Establish deep understanding of the Ethereum model, its consensus model and code execution.

CO5: Understand the architectural components of a Hyperledger and its development framework.

CO6:Aware of the alternative blockchains and emerging trends in blockchain

Pre–requisite : Nil

Cos	PROGRAMME OUTCOMES (POs) (S/M/W Indicates Strength of Correlation) S-Strong, M-Medium, W- Weak											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S		S	S								
CO2		S	S			S				S		
CO3				S								
CO4			S	S	M				M			
CO5				S	S				S			
CO6									S			S

COURSE ASSESSMENT METHODS

DIRECT

1. Continuous Assessment Test I, II
2. Assignment
3. Demonstration etc
4. End Semester Examination

INDIRECT

1. Course-end survey

INTRODUCTION TO BLOCKCHAIN	9 Hours

History of Blockchain – Types of Blockchain – Consensus – Decentralization using Blockchain – Blockchain and Full Ecosystem Decentralization – Platforms for Decentralization.

INTRODUCTION TO CRYPTOCURRENCY	9 Hours

Bitcoin – Digital Keys and Addresses – Transactions – Mining – Bitcoin Networks and Payments – Wallets – Alternative Coins – Theoretical Limitations – Bitcoin limitations – Name coin – Prime coin – Zcash – Smart Contracts – Ricardian Contracts.

ETHEREUM	9 Hours
The Ethereum Network – Components of Ethereum Ecosystem – Ethereum Programming Languages: Runtime Byte Code, Blocks and Blockchain, Fee Schedule – Supporting Protocols – Solidity Language	

WEB3 and HYPER LEDGER	9 Hours
Introduction to Web3 – Contract Deployment – POST Requests – Development Frameworks – Hyperledger as a Protocol – The Reference Architecture – Hyperledger Fabric – Distributed Ledger – Corda.	

ALTERNATIVE BLOCKCHAINS AND NEXT EMERGING TRENDS	9 Hours
Kadena – Ripple – Rootstock – Quorum – Tendermint – Scalability – Privacy – Other Challenges – Blockchain Research – Notable Projects – Miscellaneous Tools	

Theory: 45	Tutorial: -	Total Hours: 45 Hours

REFERENCES

1. Imran Bashir, "Mastering Blockchain: Distributed Ledger Technology, Decentralization and Smart Contracts Explained", 2 nd , Edition, Packt Publishing, 2018.
2. ArshdeepBahga, Vijay Madisetti, "Blockchain Applications: A Hands On Approach", VPT Publisher,2017.
3. Andreas Antonopoulos, Satoshi Nakamoto, "Mastering Bitcoin", O'Reilly, 2014.
4. Roger Wattenhofer, "The Science of the Blockchain" Create Space Independent Publishing, 2016.
5. A. Narayanan, J. Bonneau, E. Felten, A. Miller, S. Goldfeder, "Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction", Princeton University Press, 2016.
6. Alex Leverington, "Ethereum Programming", Packt Publishing, 2017.

P20CAE0009	ACCOUNTING AND FINANCIAL MANAGEMENT	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Understand the balance sheet preparation and do analysis.

CO2: Understand the cost sheet, budget preparation and control of a company.

CO3: Decide about the state of affairs of a particular firm / company.

CO4: Ensure the preparation of fiscal policies of the organization.

CO5: Ensures the factors to be considered in investment policies.

CO6: Estimate the various business activities such as purchase, sale, production and cash budgets.

Pre–requisite : Nil

Cos	PROGRAMME OUTCOMES (POs) (S/M/W Indicates Strength of Correlation) S-Strong, M-Medium, W- Weak											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		S						M				
CO2								M				S
CO3									M			M
CO4									M			
CO5										M		
CO6								S			M	

COURSE ASSESSMENT METHODS

 DIRECT

1. Continuous Assessment Test I, II
2. Assignment; Group Presentation
3. End Semester Examination

 INDIRECT

 1. Course-end survey

FINANCIAL ACCOUNTING	9 Hours

Meaning and Scope of Accounting – Principles – Concepts and Conventions – Double Entry Book Keeping – Books of Accounts: Preparation of Journals – Ledger – Trial Balance – Trading, Profit and Loss Account – Balance Sheet.

COST ACCOUNTING	9 Hours

Meaning – Objectives – Elements of Cost – Preparation of Cost Sheet – Methods of Costing – Marginal Costing – Cost Volume Profit Analysis – Break Even Analysis – Fund Flow Analysis – Cash Flow Analysis.

BUDGETS AND BUDGETARY CONTROL	9 Hours
Budgets and Budgetary Control – Meaning – Types – Sales Budget – Production Budget – Cost of Production Budget – Flexible Budgeting – Cash Budget – Master Budget – Zero Base Budgeting.	

FINANCIAL MANAGEMENT AND COST OF CAPITAL	9 Hours
Objectives and Functions of Financial Management – Cost of Capital – Factors Affecting Cost of Capital – Capital Budgeting: Net Present Value – Internal Rate of Return – Profitability Index – Pay – Back and Discounted Pay – Back Method	

CAPITAL STRUCTURE AND WORKING CAPITAL MANAGEMENT	9 Hours
Capital Structure – Factors Affecting Capital Structure – Dividend Policy – Types of Dividend Policy – Concepts of Working Capital – Working Capital Policies – Factors Affecting Working Capital – Estimation of Working Capital Requirements.	

Theory: 45	Tutorial: NIL	Total : 45 Hours

REFERENCES

1. S.N.Maheswari, "Financial and Management Accounting", Sultan Chand & Sons, 2015.
2. R.K Sharma and Shashi V. K.Gupta, "Management Accounting: Principles of Practice", Kalyani Publishers, 2015.
3. I.M.Pandey, "Financial Management", Vikas Publications, 2014.
4. S.P.Iyengar, "Cost and Management Accounting", Sultan Chand & Co, 2014.
5. I.M.Pandey, "Elements of Management Accounting", Vikas Publishing House, 2014.
6. R.L Gupta and V.K.Gupta, "Financial Accounting", Sultan Chand & Sons, 2015.

P20CAE0010	ENTERPRISE RESOURCE PLANNING	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Have a sound knowledge on the basic concept of ERP.
CO2: Build a business model in an ERP package.
CO3: Understand the advantages of the ERP solution.
CO4: Be aware of the various commercial ERP packages.
CO5: Know the architecture concepts and services of an ERP package

Pre–requisite : Nil

Cos	PROGRAMME OUTCOMES (POs) (S/M/W Indicates Strength of Correlation) S-Strong, M-Medium, W- Weak											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	M	S			S	M					
CO2		W										W
CO3	M	S	M			M			W			
CO4				M			M					M
CO5	W		S			W	W					

COURSE ASSESSMENT METHODS

DIRECT

   1.Continuous Assessment Test I, II
   2.Assignment; Group Presentation
   3.End Semester Examination

INDIRECT

   1.Course-end survey

INTRODUCTION TO ERP	4 Hours

Integrated Management Information Seamless Integration – Supply Chain Management – Integrated Data Model – Benefits of ERP

BUSINESS ENGINEERING	5 Hours

Business Engineering and ERP – Definition of Business Engineering – Principle of Business Engineering – Business Engineering with Information Technology-Introduction to Business Process Reengineering.

BUSINESS MODELLING FOR ERP	9 Hours
Building the Business Model – ERP Implementation – An Overview – Role of Consultant, Vendors and Users – Customization – Precautions – ERP Post Implementation Options – ERP Implementation Technology – Guidelines for ERP Implementation.	
ERP AND THE COMPETITIVE ADVANTAGE	9 Hours
ERP domain Manufacturing (MFG)/Pro – Industrial and Financial Systems (IFS)/Avalon – Industrial and Financial Systems – Baan IV, Systems Applications and Products (SAP) – Market Dynamics and Dynamic Strategy.	
COMMERCIAL ERP PACKAGE	9 Hours
Description – Multi–Client/Server Solution – Open Technology – User Interface – Application Integration.	
ARCHITECTURE	9 Hours
Basic Architectural Concepts – The System Control Interfaces – Services – Presentation Interface – Database Interface.	

Theory: 45 Hours.	Tutorial:	Total :45 Hours

REFERENCES
1. Vinod Kumar Garg & N.K.Venkita Krishnan, "Enterprise Resource Planning – Concepts and Practice", 2nd Edition, PHI Learning Pvt. Ltd., 2011. 2. Alexis Leon, "Enterprise Resource Planning, Fourth Edition, McGraw Hill Publications, 2019 3. Jose Antonio Fernandz, "The SAP R/3 Handbook", TMH, 2005. 4. M. S. Jayaraman, Ganesh Natarajan, & A.V. Rangaramanujan, "Business Process Reengineering", McGraw Hill, 2001 5. R. Srinivasan, "Business Process Reengineering, 2nd Edition, McGrawhill,2019.

P20CAE0011	**BUSINESS DOMAINS IN COMPUTER APPLICATIONS**	**L**	**T**	**P**	**J**	**C**
		3	**0**	**0**	**0**	**3**

Course Outcomes

After successful completion of this course, the students should be able to

CO1**:** Describe about marketing, consumer behaviour and marketing segmentation.

CO2**:** Explain about human resource management and terms associated with it.

CO3**:** Understand the need for supply chain management and inventory control techniques.

CO4**:** Explain about customer relationship management in various domains.

CO5**:** Know the basics of banking and insurance process.

Pre–requisite **:**Nil

Cos	**PROGRAMME OUTCOMES (POs)** **(S/M/W Indicates Strength of Correlation) S-Strong, M-Medium, W- Weak**											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	S	S						M				
CO2						M		S		S		
CO3												S
CO4											S	
CO5										S		

COURSE ASSESSMENT METHODS

DIRECT

. 1. Continuous Assessment Test I, II

. 2. Assignment

. 3. Demonstration etc (as applicable)

. 4. End Semester Examination

INDIRECT

1.Course-end survey

MARKETING	**8 Hours**

Definition - Importance of Consumer Behavior- Steps in Buyer Decision Process - Market Segmentation- Marketing Mix: 7 Ps of Marketing.

HUMAN RESOURCEMANAGEMENT	**7 Hours**

Employee Database- Recruitment -Selection Processes- Employee Appraisal- Leave Types- Payroll – Salary Calculation - Income Tax Calculation – Reporting – PF – Gratuity - Bonus.

SUPPLY CHAIN MANAGEMENT (SCM)	10 Hours
Introduction to Supply Chain -Major Drivers of Supply Chain- Value in Supply Chain- Quality, Delivery, Flexibility- Source Management in Supply Chain- In Sourcing-Outsourcing- Make Vs Buy- Managing Inventory in Supply Chain- Definition of Inventories- Role of Inventory- Inventory Control Techniques (ABC Analysis, VED Analysis)- Vendor Managed Inventory- Transportation– Modes of Transportation-Transportation Management System (TMS).	

CUSTOMER RELATIONSHIP MANAGEMENT (CRM)	10 Hours
Introduction to CRM -Need for CRM- Customer Life Cycle- Use of CRM in Business - CRM Implementation Strategy- CRM Applications in Hospital Management-Travel Industry- Hotel Industry.	

BANKING AND INSURANCE	10 Hours
Accounts and Deposits- Types of Accounts-Saving Account-Current Account- Demat Account-Digital Payments – NEFT- RTGS- IMPS- BHIM- UPI-Wallets. Loans - Various Types of Loans- Personal-Home Loan-Vehicle Loan - Loan Against Security - Business Loans- Loan Sanction Process- Insurance- Types of Insurance- Life- Health- Accident-Home- Motor- Loan Insurance- Insurance Processes.	

Theory: 45 Hours	Tutorial: -	Total : 45 Hours

REFERENCES:

1. Philip Kotler, K.Keller, "Marketing Management: A South Asian Perspective", Pearson Education, 15th Edition, 2017.
2. Sunil Chopra, Peter Meindl, "Supply Chain Management Strategy, Planning and Operation" Pearson Education, 6th Edition, 2016.
3. J. John Bernardin," Human Resource Management ", Tata McGraw Hill Publishing, 6th Edition 2012.
4. Kristin Anderson , Carol Kerr,"Customer Relationship Management", Tata McGraw- Hill,2001
5. Padmalatha Suresh, Justin Paul ,"Management of Banking and Financial Services", Pearson Education, 8th Edition, 2017.
7. Francis Buttle, Stan Maklan, "Customer Relationship Management: Concepts and Technologies", Routledge, 3rd edition,2015

P20CAE0012	BIG DATA ANALYTICS	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Work with big data platform and Understand the fundamentals of various big data analysis techniques.

CO2: Analyze the big data analytic techniques for useful business applications.

CO3: Design efficient algorithms for mining the data from large volumes

CO4: Analyze the HADOOP and Map Reduce technologies associated with big data analytics.

CO5: Explore the applications of Big Data.

Pre–requisite : P20CAT1002 **-** Database Technologies

Cos	PROGRAMME OUTCOMES (POs) (S/M/W Indicates Strength of Correlation) S-Strong, M-Medium, W- Weak											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		S			M							
CO2					M				M		M	
CO3		W	M	W	W				M		M	
CO4					M						M	
CO5									W		W	

COURSE ASSESSMENT METHODS
DIRECT
1. Continuous Assessment Test I, II 2. Assignment 3. Demonstration etc (as applicable) . 4. End Semester Examination
INDIRECT
1.Course-end survey

INTRODUCTION TO BIG DATA	9 Hours

Introduction to Big Data Platform –Challenges of Conventional Systems -Intelligent data analysis – Nature of Data-Analytic Processes and Tools -Analysis vs Reporting -Modern Data Analytic Tools - Statistical Concepts: Sampling Distributions -Re-Sampling -Statistical Inference -Prediction Error

MINING DATA STREAMS	9 Hours

Introduction To Streams Concepts –Stream Data Model and Architecture -Stream Computing - Sampling Data in a Stream –Filtering Streams –Counting Distinct Elements in a Stream –Estimating Moments–Counting Oneness in a Window –Decaying Window -Real time Analytics Platform(RTAP)Applications –-Case Studies -Real Time Sentiment Analysis, Stock Market Predictions.

HADOOPENVIRONMENT	9 Hours

History of Hadoop-The Hadoop Distributed File System –Components of Hadoop-Analyzing the Data with Hadoop -Scaling Out-Hadoop Streaming-Design of HDFS-Hadoop file systems-Java interfaces to HDFS-Basics-Developing a Map Reduce Application-How Map Reduce Works-Anatomy of a Map Reduce Job run-Failures-Job Scheduling-Shuffle and Sort –Task execution -Map Reduce Types and Formats-Map Reduce Features -Setting up a Hadoop Cluster -Cluster specification -Cluster Setup and Installation –Hadoop Configuration-Security in Hadoop.

DATA ANALYSIS SYTEMS AND VISUALIZATION	9 Hours

Link Analysis –Page Rank -Efficient Computation of Page Rank-Topic-Sensitive Page Rank –Link Spam-Recommendation Systems-A Model for Recommendation Systems-Content-Based Recommendations -Collaborative Filtering -Dimensionality Reduction-Visualizations -Visual data analysis techniques-interaction techniques-Systems and applications.

FRAMEWORKS AND APPLICATIONS	9 Hours

IBM for Big Data –Framework -Hive –Sharding –NoSQL Databases –Mango DB-Casandra-Hbase – Impala –Analyzing big data with twitter –Big data for Ecommerce –Big data for blogs.

Theory: 45 Hours	Tutorial: -	Total: 45 Hours

REFERENCES

1. Tom White, "Hadoop: The Definitive Guide", 3rd Edition, O'reilly Media, 2012.
2. Paul Zikopoulos, Chris Eaton, Dirk Deroos, Tom Deutsch, George Lapis, "Understanding Big Data: Analytics for Enterprise Class Hadoop and Streaming Data", McGraw Hill Publishing, Indian Edition,2017.
3. Bill Franks," Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams withAdvanced Analyt.ics", John Wiley &Sons, 2012.
4. Zikopoulos, Paul & Chris Eaton, "Understanding Big Data: Analytics for Enterprise Class Hadoop andStreaming Data", Tata McGraw Hill Publications, 2011.
5. Anand Rajaraman and Jeffrey David Ullman, "Mining of Massive Datasets", Cambridge UniversityPress, 2014
6. Paul Zikopoulos, DirkdeRoos , Krishnan Parasuraman ,Thomas Deutsch , James Giles , David Corrigan , Harness the Power of Big Data The IBM Big Data Platform, Tata McGraw Hill Publications,2012.

P20CAE0013	MIXED REALITY	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Discuss the basic concepts of Mixed Reality.

CO2: Design and develop the Mixed Reality applications in different

domains.CO3: Design various models using modelling techniques.

CO4: Perform Mixed Reality Programming with toolkits.

CO5: Understand the working principles of input output devices used in mixed reality applications.

CO6: Evaluate mixed reality based applications.

Pre–requisite : Nil

Cos	PROGRAMME OUTCOMES (POs) (S/M/W Indicates Strength of Correlation) S-Strong, M-Medium, W-Weak											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S											
CO2		S						M				
CO3			S	M								
CO4					S							
CO5			S		S							
CO6				S						M		M

COURSE ASSESSMENT METHODS

DIRECT

. 1.Continuous Assessment Test I, II

. 2. Assignment

. 3. Demonstration etc

4. End Semester Examination

INDIRECT

1. Course-end survey

INTRODUCTION	**9 Hours**

Introduction to Virtual Reality (VR)– Definition – Three I's of VR – VR Vs 3D Computer Graphics – Benefits - Components of VR– Introduction to AR – System Structure– Key Technology in AR – 3D Vision – Approaches - Alternative Interface Paradigms – Spatial AR – Input Devices – 3D Position Trackers – Performance Parameters – Types of Trackers – Navigation and Manipulation Interfaces –Gesture Interfaces – Types of Gesture Input Devices – Output Devices – Graphics Display –Human Visual System – Personal Graphics Displays – Large Volume Displays – Sound Displays –Human Auditory System.

MR COMPUTING ARCHITECTURE	**9 Hours**

Computing Architectures of VR – Rendering Principle – Graphics and Haptics Rendering –PC Graphics Architecture – Graphics Accelerators – Graphics Benchmarks – Workstation Based Architectures – SGI Infinite Reality Architecture – Distributed VR Architectures – Multi-pipeline

Synchronization – Collocated Rendering Pipelines – Distributed Virtual Environments – AR Architecture.	

MR MODELING	**9 Hours**
Modeling – Geometric Modeling – Virtual Object Shape – Object Visual Appearance – Kinematics Modeling – Transformation Matrices – Object Position – Transformation Invariants – Object Hierarchies – Viewing The 3D World – Physical Modeling – Collision Detection – Surface Deformation – Force Computation – Force Smoothing And Mapping – Behavior Modeling – Model Management.	

MR PROGRAMMING	**9 Hours**
VR Programming – Toolkits and Scene Graphs – World Toolkit – Java 3D – Comparison of World Toolkit and Java 3D - GHOST – People Shop – Human Factors in VR – Methodology and Terminology – VR Health and Safety Issues – VR and Society –Mixed Reality Coding –Trajectories through Mixed Reality Performance – Mobile Interface Design – Quantitative Evaluation – Qualitative Evaluation.	

APPLICATIONS	**9 Hours**
Medical Applications of MR – Education, Arts and Entertainment – Military MR Applications – Emerging Applications of MR – MR Applications in Manufacturing – Applications of MR in Robotics – Information Visualization –Wearable Computing – Games	

Theory: 45	Tutorial: -	Total : 45 Hours

REFERENCES

1. Grigore C. Burdea, Philip Coiffet, "Virtual Reality Technology", Second Edition, Wiley India, 2017.
2. Benford, S., Giannachi G., "Performing Mixed Reality", MIT Press, 2011.
3. Charles Palmer, John Williamson, "Virtual Reality Blueprints: Create Compelling VR Experiences for Mobile", Packt Publisher, 2018.
4.Jason Jerald, "The VR Book: Human-Centered Design for Virtual Reality" Association for Computing Machinery and Morgan , Claypool Publishers,2015
5. William R. Sherman, Alan B.Craig: Understanding Virtual Reality – Interface, Application, Design", Morgan Kaufmann, 2003
6.Kelly S. Hale , Kay M. Stanney Handbook of Virtual Environments: Design, Implementation, and Applications, Second Edition, CRC press,2014

P20CAE0014	DEEP LEARNING TECHNIQUES AND APPLICATIONS	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Understand the role of deep learning in machine learning applications.

CO2: Get familiar with the use of Tensor Flow and Keras in deep learning applications.

CO3: Design and implement deep learning applications.

CO4: Critically analyze different deep learning models in image related projects.

CO5: Design and implement convolutional neural networks.

Pre–requisite : P20CAT2003 – Data Intensive Computing

Cos	PROGRAMME OUTCOMES (POs) (S/M/W Indicates Strength of Correlation) S-Strong, M-Medium, W- Weak											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		M							W			
CO2					S		M				M	
CO3		M					M				M	
CO4		W			M				W			
CO5							M					

COURSE ASSESSMENT METHODS

DIRECT

1. Continuous Assessment Test I, II
2. Assignment
3. Demonstration etc
4. End Semester Examination

INDIRECT

1. Course-end survey

BASICS OF NEURAL NETWORKS	9 Hours

Basic Concept of Neurons – Perceptron Algorithm – Feed Forward and Backpropagation Networks

INTRODUCTION TO DEEP LEARNING	9 Hours

Deep Feed-Forward Neural Networks – Gradient Descent – Back-Propagation and Other Differentiation Algorithms – Vanishing Gradient Problem – Mitigation – Rectified Linear Unit (ReLU) – Heuristics for Avoiding Bad Local Minima – Heuristics for Faster Training –Nestor's Accelerated Gradient Descent – Regularization for Deep Learning – Dropout – Adversarial Training – Optimization for Training Deep Models

CONVOLUTIONAL NEURAL NETWORKS	9 Hours

CNN Architectures – Convolution – Pooling Layers – Transfer Learning – Image Classification using Transfer Learning – Recurrent and Recursive Nets – Recurrent Neural Networks – Deep Recurrent Networks – Recursive Neural Networks-Applications

ADDITIONAL DEEP LEARNING ARCHITECTURES	9 Hours

Long Short Term Memory (LSTM) Networks – Sequence Prediction – Gated Recurrent – Encoder/Decoder Architectures – Autoencoders – Standard – Sparse – Denoising – Contractive – Variational Autoencoders – Applications of Autoencoders – Representation Learning – Deep generative Models – Belief Networks – Generative Networks – Generative Schemes – Evaluating Generative Models.

APPLICATIONS OF DEEP LEARNING	9 Hours

Images segmentation – Object Detection – Automatic Image Captioning – Image generation with Generative adversarial networks – Attention models for Computer Vision – Case Study: Named Entity Recognition – Opinion Mining using Recurrent Neural Networks – Parsing and Sentiment Analysis using Recursive Neural Networks

Theory: 45	Tutorial: -	Total : 45 Hours

REFERENCES

1. Ian J. Goodfellow, YoshuaBengio, Aaron Courville, "Deep Learning", MIT Press, 2017.
2. Francois Chollet, "Deep Learning with Python", Manning Publications, 2018
3. Phil Kim, "Matlab Deep Learning: With Machine Learning, Neural Networks and Artificial Intelligence", Apress, 2017.
4. Ragav Venkatesan, Baoxin Li, "Convolutional Neural Networks in Visual Computing", CRC Press, 2018.
5. Navin Kumar Manaswi, "Deep Learning with Applications Using Python", Apress, 2018.
6. Joshua F. Wiley, "R Deep Learning Essentials", Packt Publications, 2016.Joshua F. Wiley, "R Deep Learning Essentials", Packt Publications 2016.

P20CAE0015	E-LEARNING TECHNIQUES	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Distinguish the phases of activities in the models of E-learning.

CO2: Identify appropriate instructional methods and delivery

strategies.CO3: Choose appropriate E-learning authoring tools.

CO4: Create interactive E-Learning

courseware.CO5: Evaluate the E-learning

courseware.

CO6: Manage the E-learning courseware

Pre–requisite : Nil

Cos	PROGRAMME OUTCOMES (POs) (S/M/W Indicates Strength of Correlation) S-Strong, M-Medium, W-Weak											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		S					S					
CO2		M	S		M							
CO3			M			W	W					
CO4		S	M		S	W						
CO5				M								
CO6								M		W		

COURSE ASSESSMENT METHODS

DIRECT

. 1.Continuous Assessment Test I, II

. 2. Assignment

. 3. Demonstration etc

4. End Semester Examination

INDIRECT

1.Course-end survey

INTRODUCTION	9 Hours

Need for E-Learning – Approaches of E-Learning – Components of E-Learning – Synchronous and Asynchronous Modes of Learning – Quality of E-Learning – Blended Learning: Activities, Team and Technology – Work Flow to Produce and Deliver E-Learning Content – Basics of Design Thinking.

DESIGNING E-LEARNING COURSE CONTENT	9 Hours

Design Models of E-Learning – Identifying and Organizing E-Learning Course Content: Needs Analysis – Analyzing the Target Audience – Identifying Course Content – Defining Learning Objectives – Defining the Course Sequence – Defining Instructional Methods – Defining Evaluation and Delivery Strategies -Case Study

CREATING INTERACTIVE CONTENT	9 Hours
Preparing Content: Tips for Content Development and Language Style – Creating Storyboards: Structure of an Interactive E-Lesson – Techniques for Presenting Content – Adding Examples – Integrating Multimedia Elements – Adding Examples – Developing Practice and Assessment Tests – Adding Additional Resources– Courseware Development – Authoring Tools – Types of Authoring Tools – Selecting an Authoring Tool.	

LEARNING PLATFORMS	9 Hours
Types of Learning Platforms – Proprietary Vs. Open – Source LMS – LMS Vs LCMS – Internally Handled and Hosted LMS – LMS Solutions – Functional Areas of LMS.	

COURSE DELIVERY AND EVALUATION	9 Hours
Components of an Instructor-Led or Facilitated Course – Planning and Documenting Activities – Facilitating Learners Activities – E-Learning Methods and Delivery Formats – Using Communication Tools for E-Learning – Course Evaluation.	

Theory: 45	Tutorial: -	Total : 45 Hours

REFERENCES

1. Clark, R. C. and Mayer, R. E, "eLearning and the Science of Instruction", Third Edition, John Wiley, 2016.
2. Means, B., Toyama, Y., and Murphy, R, "Evaluation of Evidence – Based Practices in Online Learning: A Meta – Analysis and Review of Online Learning Studies", Centre for Learning Technologies, 2010.
3. Crews, T. B., Sheth, S. N., and Horne, T. M, "Understanding the Learning Personalities of Successful Online Students", Educause Review, 2014.
4. Johnny Schneider, "Understanding Design Thinking, Lean and Agile", O'Riley Media, 2017.
5. Madhuri Dubey, "Effective E – learning Design, Development and Delivery", University Press, 2011.

P20CAE0016	ETHICAL HACKING	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO 1: Apply various open source security tools to assess the network and
   computingsystem.

CO2: Practice penetration testing to predict the vulnerabilities across any computing system.

CO3: Explain how to prevent the information and computing assets from any kind of attacks.

CO 4: Understand how to protect the devices in a network from malicious software and
worms.

CO 5: Assess the wireless network flaws and be able to provide security solution.

Pre–requisite :P20CAT2004 - Data Communications and Networks

Cos	PROGRAMME OUTCOMES (POs) (S/M/L Indicates Strength of Correlation) S-Strong, M-Medium, L- Less											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M				S	M						
CO2	M	W			M	S				M		
CO3	M	M							W			
CO4	W		S	M	M							
CO5	M	S					M					

COURSE ASSESSMENT METHODS

DIRECT

. 1.Continuous Assessment Test I, II

. 2. Assignment

. 3. Demonstration etc

4. End Semester Examination

INDIRECT

1.Course-end survey

INTRODUCTION	**9 Hours**

Introduction to Hacking – Important Terminologies – Penetration Test – Vulnerability Assessments versus Penetration Test – Pre-Engagement – Rules of Engagement – Penetration Testing Methodologies – OSSTMM – NIST – OWASP – Categories of Penetration Test – Types ofPenetration Tests – Vulnerability Assessment Summary – Reports.

INFORMATION GATHERING AND SCANNING	**9 Hours**

Information Gathering Techniques – Active Information Gathering – Passive Information Gathering-– Sources of Information Gathering – Tracing the Location – Traceroute – ICMP Traceroute – TCP

Traceroute – Usage – UDP Traceroute – Enumerating and Fingerprinting the Webservers – Google Hacking – DNS Enumeration – Enumerating SNMP – SMTP Enumeration – Target Enumeration and Port Scanning Techniques – Advanced Firewall/IDS Evading Techniques.

NETWORK ATTACKS	9 Hours

Vulnerability Data Resources – Exploit Databases – Network Sniffing – Types of Sniffing – Promiscuous versus Non-promiscuous Mode – MITM Attacks – ARP Attacks – Denial of Service Attacks –Hijacking Session with MITM Attack – SSL Strip: Stripping HTTPS Traffic –DNS Spoofing – ARP Spoofing Attack Manipulating the DNS Records – DHCP Spoofing – Remote Exploitation – Attacking Network Remote Services – Overview of Brute Force Attacks – Traditional Brute Force – Attacking SMTP – Attacking SQL Servers – Testing for Weak Authentication.

EXPLOITATION	9 Hours

Introduction to Metasploit – Reconnaissance with Metasploit – Port Scanning with Metasploit – Compromising a Windows Host with Metasploit – Client Side Exploitation Methods – E–Mails with Malicious Attachments – Creating a Custom Executable – Creating a Backdoor with SET – PDF Hacking – Social Engineering Toolkit – Browser Exploitation – Post–Exploitation – Acquiring Situation Awareness – Hashing Algorithms – Windows Hashing Methods – Cracking the Hashes – Brute force Dictionary Attacks – Password Salts – Rainbow Tables – John the Ripper – Gathering OS Information – Harvesting Stored Credentials

WIRELESS AND WEB HACKING	9 Hours

Wireless Hacking – Introducing Aircrack– Cracking the WEP – Cracking a WPA/WPA2 Wireless Network Using Aircrack-ng – Evil Twin Attack – Causing Denial of Service on the Original AP – Web Hacking – Attacking the Authentication – Brute Force and Dictionary Attacks – Types of Authentication – Log-In Protection Mechanisms – Captcha Validation Flaw – Captcha RESET Flaw – Manipulating User-Agents to Bypass Captcha and Other Protection – Authentication Bypass Attacks – Testing for the Vulnerability – Automating It with Burp Suite – Session Attacks – SQL Injection Attacks

Theory: 45	Tutorial: -	Total : 45 Hours

REFERENCES

1. Rafay Baloch, "Ethical Hacking and Penetration Testing Guide", CRC Press, 2014.
2. Kevin Beaver, "Ethical Hacking for Dummies", Sixth Edition, Wiley, 2018.
3. Jon Erickson , "Hacking: The Art of Exploitation", Second Edition, Rogunix, 2007.

P20CAE0017	MIDDLEWARE TECHNOLOGIES	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Implement the distributed services using RMI

.CO2: Implement programs in EJB.

CO3: Map and differentiate the functions between COM and .NET.

CO4: Understand the functionalities of various types of middleware

technologies.CO5: Design web services using SOAP, UDDI, WSDL.

CO6: Design middleware applications for real time usage.

Pre–requisite: P20CAT1004 - Programming with JAVA

Cos	PROGRAMME OUTCOMES (POs) (S/M/W Indicates Strength of Correlation) S-Strong, M-Medium, W-Weak											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	M	S		M		M					
CO2	S		S		M							
CO3	S	M	M				S					
CO4	S		S		S							M
CO5												
CO6					M							M

COURSE ASSESSMENT METHODS

DIRECT

1. Continuous Assessment Test I, II

2. Assignment

3. Demonstration etc

4. End Semester Examination

INDIRECT

1. Course-end survey

INTRODUCTION	**9 Hours**

General Middleware, Service Specific Middleware, Client/Server Building blocks – RPC - Messaging – Peer – to – Peer, Java RMI - Computing standards – OMG - Overview of EJB - Middleware types - Middleware in distributed Applications.

EJB	**9 Hours**

EJB architecture - Overview of EJB software architecture, EJB Conversation, Building and Deploying EJBs, Roles, applications - EJB Session Beans, EJB entity beans - Lifecycle of Beans - EJB clients -developing an application - Deployment.

COM and .NET	9 Hours
Evolution of DCOM - Introduction to COM - COM clients and servers - COM IDL - COM Interfaces COM Threading Models – Marshalling - Custom and standard marshalling - Introduction to .NET - Overview of .NET architecture - Remoting	

SOA and WEB SERVICES	9 Hours
Defining SOA - Business value of SOA - SOA characteristics - Concept of a service, Basic SOA - Enterprise Service Bus (ESB) - SOA enterprise Software Models -Services and SOA – WSDL - SOAP, UDDI, WS Standards -Web Services and Service Oriented Enterprise (SOE) - Coordination and Transaction - Business Process Execution Language for Web Services.	

OTHER TYPES OF MIDDLEWARE	9 Hours
Other types of Middleware, Real-Time Middleware, Embedded Systems Middleware, Mobile Middleware, Oracle Fusion Middleware	

Theory: 45	Tutorial: -	Total : 45 Hours

REFERENCES

1. Letha Hughes Etzkorn,Introduction to Middleware: Web Services, Object Components, and Cloud Computing, 1st Edition, Chapman and Hall/CRC ,2017.
2. Judith M. Myerson, "The Complete Book of Middleware" Auerbach Publications, 1 st Edition, 2017
3. G. Sudha Sadasivam, Radha Shankarmani, "Middleware and Enterprise Integration Technologies", Wiley, 2009. Tentative
4. Gustavo Alonso, Fabio Casati, Harumi Kuno, Vijay Machiraju, "Web Services: Concepts, Architectures and Applications", Springer, 2010.
5. Ian Gorton, "Essential Software Architecture", Springer, 2nd Edition, 2011.
6. Distributed Systems Architecture: A Middleware Approach", Morgan Kaufmann, 2005.
7. Reza Shafii, Stephen Lee, and Gangadhar Konduri, "Oracle Fusion Middleware 11g Architecture and Management", McGraw-Hill Osborne Media, 1 edition, 2011.
8. Grigoris Antoniou & Frank Van, "Semantic Web Primer", 2012

P20CAE0018	ROBOTIC PROCESS AUTOMATION	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Understand the need and use of automation

CO2: Describe RPA, where it can be applied and how its implemented

CO3: Describe the different types of variables, Control Flow, and data manipulation techniquesCO4: Identify and understand Image, Text, and Data Tables Automation

CO5: Describe automation to Email and various types of Exceptions and strategies to handle

CO6: Build Bots which can do

Pre–requisite : Nil

Cos	PROGRAMME OUTCOMES (POs) (S/M/W Indicates Strength of Correlation) S-Strong, M-Medium, W-Weak											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	S										
CO2		S	M		M							
CO3					S							
CO4	M			M								
CO5			M									
CO6			M									

COURSE ASSESSMENT METHODS

DIRECT

1. Continuous Assessment Test I, II
2. Assignment
3. Demonstration etc
4. End Semester Examination

INDIRECT

1. Course-end survey

RPA CONCEPTS	9 Hours

RPA Basics - History of Automation - RPA vs Automation - Processes & Flowcharts - ProgrammingConstructs in RPA - Processes Automation - Types of Bots - Workloads which can be automated - Advanced Concepts - Standardization of processes - Tentative Development methodologies - Difference from SDLC - Robotic control flow architecture - RPA business case - Team - Process Design and Solution Design Document - Industries suited for RPA - Risks & Challenges - RPA and Emerging Ecosystem

RPA TOOL	9 Hours
Introduction to RPA Tool - User Interface - Variables - Managing Arguments - Naming Best Practices - Arguments Panel - Using Arguments -Imported Namespaces - Control Flow : Introduction - If Else Statements - Loops - Advanced Control Flow - Sequences - Flowcharts - Control Flow Activities - Data Manipulation -Introduction - Scalar variables, Collections and Tables - Text Manipulation - Gathering and Assembling Data	

AUTOMATION CONCEPTS	9 Hours
Recording and Advanced UI Interaction -Introduction – Basics - Desktop Recording - Web Recording - Input/Output Methods - Screen Scraping - Data Scraping - Scraping advanced techniques - Selectors - Selectors - Defining and Assessing Selectors - Customization - Debugging - Dynamic Selectors - Partial Selectors	

ADVANCED AUTOMATION CONCEPTS AND TECHNIQUES	9 Hours
RPA Challenge - Image, Text & Advanced Citrix Automation - Introduction to Image & Text Automation - Information Retrieval - Challenges - Best Practices - Using tab for Images - Starting Apps - Excel Data Tables & PDF - Data Tables in RPA - Excel and Data Table basics - Data Manipulation in excel - Extracting Data from PDF - Anchors - Anchors in PDF.	

EMAIL AUTOMATION & EXCEPTIONAL HANDLING	9 Hours
Email Automation - Email Automation - Incoming Email automation - Sending Email automation - Debugging and Exception Handling - Debugging Tools - Strategies for solving issues - Catching errors.	

Theory: 45	Tutorial: -	Total: 45 Hours

REFERENCES

1. Alok Mani Tripathi, Learning Robotic Process Automation, Publisher: Packt Publishing Release Date: March 2018 .
2. Frank Casale, Rebecca Dilla, Heidi Jaynes, Lauren Livingston, "Introduction to Robotic Process Automation: A Primer, Institute of Robotic Process Automation", 2015.
3. Richard Murdoch, "Robotic Process Automation: Guide to Building Software Robots, Automate Repetitive Tasks & Become an RPA Consultant", 2018.
4. Srikanth Merianda, "Robotic Process Automation Tools, Process Automation and their benefits: Understanding RPA and Intelligent Automation", 2018.

P20CAE0019	LINUX ADMINISTRATION	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Understand an overall view of the structure of Linux.

CO2: Access the different devices through commands.

CO3: Work with kernel and user spaces in Linux environment.

CO4: Automate tasks using scheduling tools.

CO5: Configure network files based on the specific need.

CO6: Acquire Linux Administration skills to manage a server.

Pre–requisite : P20CAT1103- Advanced Operating Systems

Cos	PROGRAMME OUTCOMES (POs) (S/M/W Indicates Strength of Correlation) S-Strong, M-Medium, W- Weak											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	S					M					
CO2	S	M				M						
CO3	W				S	M	M					
CO4		W			S							
CO5	S				S		M					
CO6	S				S	M	M					

COURSE ASSESSMENT METHODS

DIRECT

. 1.Continuous Assessment Test I, II

. 2. Assignment

. 3. Demonstration etc

4. End Semester Examination

INDIRECT

1. Course-end survey

INTRODUCTION	9 Hours

Levels and Layers of Abstraction in a Linux System – Hardware – Kernel: Process Management, Memory Management, Device Drivers and Management, System Calls and Support – User Space – Shell Commands

DEVICES, DISKS and FILE SYSTEMS	9 Hours
Device Files – Device Path – Device Name Summary – udev – SCSI and Linux Kernel – Partitioning Disk Devices – Filesystems – Swap Space	

KERNEL SPACE AND USER SPACE	9 Hours
How the Linux Kernel Boots: Startup messages – Kernel initialization and Boot options – Kernel Tentative Parameters – Bootloaders – GRUB – UEFI – Chainloading other operating systems – How the User space starts: Introduction to Init – System V Runlevels – systemd – Upstart – System V init – Shutting down the System – Initial RAM Filesystem – Emergency booting and Single-User modeling	

SYSTEM CONFIGURATION, PROCESS AND RESOURCE UTILIZATION	9 Hours
Structure of etc – System Logging – User Management Files – Time – Scheduling Tasks with cron and at – Identification and Authentication – Process and Resource Utilization: Tracking Processes – lsof – Tracing Program Execution and System Calls – Threads – Measuring CPU Time – Adjusting Process Priorities – Load Averages – Memory – I/0 Monitoring	

NETWORK CONFIGURATION AND SERVICES	9 Hours
Network basics – Layers – Routes and Kernel Routing table – Basic ICMP and DNS tools – Physical Layer and Ethernet – Kernel Network Interfaces – NIC configuration – Resolving Hostname – Localhost – Transport layer: TCP, UDP and Services – Revisiting a Simple Local Network – Understanding DHCP – Configuring Linux as a Router – Firewalls – Ethernet, IP and ARP - Wireless Ethernet – Secure Shell ssh – Diagnostic Tool.	

Theory: 45	Tutorial: -	Total: 45 Hours

REFERENCES
1. Brian Ward, How Linux Works – what every superuser should know, Second edition ,starch press, 2015
2. https://developer.ibm.com/technologies/linux/

P20CAE0020	USER INTERFACE DESIGN AND USER EXPERIENCE	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Build UI for user Applications.

CO2: Know the UI Interaction behaviours and principles.

CO3: Evaluate UX design of any product or application.

CO4: Demonstrate UX Skills in product development.

CO5: Implement Sketching principles

CO6: Create Wireframe and Prototype

Pre–requisite : P20CAI2202- Web Technologies

Cos	PROGRAMME OUTCOMES (POs) (S/M/W Indicates Strength of Correlation) S-Strong, M-Medium, W- Weak											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S				M		M					
CO2	W	M										
CO3	M	M	M									
CO4		M			M							
CO5	M											
CO6	M				M							

COURSE ASSESSMENT METHODS
DIRECT
1. Continuous Assessment Test I, II
2. Assignment
3. Demonstration etc
4. End Semester Examination
INDIRECT
1. Course-end survey

FOUNDATIONS OF DESIGN	9 Hours
UI vs. UX Design - Core Stages of Design Thinking - Divergent and Convergent Thinking - Brainstorming and Game storming - Observational Empathy	

FOUNDATIONS OF UI DESIGN	9 Hours
Visual and UI Principles - UI Elements and Patterns - Interaction Behaviours and Principles – Branding - Style Guides	

FOUNDATIONS OF UX DESIGN	9 Hours
Introduction to User Experience - Why You Should Care about User Experience - Understanding User Experience - Defining the UX Design Process and its Methodology - Research in User Experience Design - Tools and Method used for Research - User Needs and its Goals - Know about Business Goals	

RESEARCH, DESIGNING, IDEATING, & INFORMATION ARCHITECTURE	9 Hours
Identifying and Writing Problem Statements - Identifying Appropriate Research Methods - Creating Personas - Solution Ideation - Creating User Stories - Creating Scenarios - Flow Diagrams - Flow Mapping - Information Architecture	

WIREFRAMING, PROTOTYPING AND TESTING	9 Hours
Sketching Principles - Sketching Red Routes - Responsive Design – Wireframing - Creating Wireflows - Building a Prototype - Building High-Fidelity Mockups - Designing Efficiently with Tools - Interaction Patterns - Conducting Usability Tests - Other Evaluative User Research Methods - Synthesizing Test Findings - Prototype Iteration	

Theory: 45	Tutorial: -	Total: 45 Hours

REFERENCES

1. Steve Krug, "Don't Make Me Think, Revisited: A Common sense Approach to Web & Mobile", Third Edition, 2015
2. Steve Schoger, Adam Wathan "Refactoring UI"2018.

ONE CREDIT COURSES

SYLLABUS

P20CAC0201	AGILE METHODOLOGY

Course Outcomes
After successful completion of this course, the students should be able to
CO 1: Understand and apply agile principles while developing software. CO 2: Establish a healthy collaboration between development teams.

AGILEPROCESS
Beginning Agility – Agile Manifesto and Principles – Agile Success Factors– Delivering what users want – Agile Planning – Caring about Quality – Collaboration – Listening to Feedback – Combining Scrum with XP – Case Studies.

Theory: 15 Hours	**Tutorial: -**	**Total: 15 Hours**

REFERENCES
1. Rachel Davies & Liz Sedley, "Agile Coaching", The Pragmatic Bookshelf, 2012. 2. Henrik Kniberg, "Scrum and XP from the Trenches–How we do Scrum", InfoQ Enterprise Software Development Series, 2007.

P20CAC0202	INTRODUCTION TO ETHICAL HACKING

Course Outcomes

After successful completion of this course, the students should be able to

CO 1: Defend a computer and network against a variety of security attacks using a number of hands–on techniques.

CO 2: Practice and use safe techniques on the World Wide Web and develop security policies.

INTRODUCTION

Introduction to Ethical Hacking – Hacking Operating System – Hacking Network – Website Hacking – Foot Printing – Checking the Status of Ports.

Phishing – Password – Privacy – Denial of Service Attacks – Microsoft Operating System Vulnerabilities – Linux Operating System Vulnerabilities – Viruses and Worms – Network Security Devices.

Theory: 15 Hours	Tutorial: -	Total: 15 Hours

REFERENCES

1. Michael T. Simpson, "Ethical Hacking and Network Defense", Cengage Learning India Private Limited, New Delhi, 2010.
2. Ankit Fadia, "An Unofficial Guide to Ethical Hacking", Macmillan India Ltd., New Delhi, 2010.

P20CAC0203	SOFT SKILLS

Course Outcomes
After successful completion of this course, the students should be able to
CO 1: Perform well in a team and positively resolve conflict in timely manner. CO 2: Set realistic goals and manage stress well.
SELF ANALYSIS & INTERPERSONAL SKILLS
Self Analysis: SWOT Analysis – Who Am I – Attributes – Importance of Self Confidence– Self Esteem. Attitude: Factors Influencing Attitude – Challenges – Lessons from Attitude – Motivation: Factors of Motivation – Self Talk – Intrinsic and Extrinsic Motivators. Goal Setting: Wish List – Smart Goals – Blue Print for Success – Short Term – Long Term – Life Time Goals.
Interpersonal Skills: Understanding the Relationship between Leadership Networking and Team Work – Necessity of Team Work – Stress Management: Causes of Stress and its Impact – How to Manage Distress – Understanding the Circle of Control – Stress Busters. Decision Making: Importance and Necessity of Decision Making – Process of Decision Making – Practical Way of Decision Making – Weighing Positives and Negatives.

Theory: 15 Hours	**Tutorial: -**	**Total: 15 Hours**

REFERENCES
1. Barun K. Mitra, "Personality Development and Soft Skills", Oxford Publisher, 2011. 2. Nitin Bhatnagar, "Effective Communication and Soft Skills", Pearson Education India 2012.

P20CAC0204	**TECHNICAL WRITING**

Course Outcomes
After successful completion of this course, the students should be able to
CO 1: Express themselves in different kind of writing from creative to critical and factual writing. CO 2: Identify and critique effective technical writing techniques and practices.
WRITING TECHNIQUES
Techniques of Writing – Emails – Minutes – Reports of different Kinds – Annual Report – Status Report – Survey Report – Proposals – Memorandums – Presentations – Interviews – Profile of Institutions – Speeches – Responding to Enquiries – Complaints – Resumes – Applications – Summarizing – Strategies for Writing.

Theory: 15 Hours	**Tutorial: -**	**Total: 15 Hours**

REFERENCES
1. Sharan J Gerson & Steven M Gerson, "Technical Writing: Process and Product", 8th Edition, Pearson Education, New Delhi, 2013.

P20CAC0205	HUMAN EXCELLENCE – PROFESSIONAL VALUES

Course Outcomes

After successful completion of this course, the students should be able to

CO 1: Acquire knowledge through personality development.
CO 2: Demonstrate skills of self–control.

INTRODUCTION,LEADERSHIP & EMPOWERMENT OF MIND

Human Excellence: Introduction – Objective – Personal Values – Importance – **Life:** Self – Society – Nature – Yoga – Purpose and Philosophy of Life – **Personality Concepts**: Introspection – Six Temperaments and their Maneuvering – Analysis of Thought – Moralizing of Desire – Neutralization of Anger – Eradication of Worries – Training: Stress Management – Time Management.

Leadership Traits: Carrying Oneself – Factors of Leadership – Principles of Leadership – **Self Control**: Importance – Techniques to Development Oneself – Ten Commandments of Self–Development – Self–Control Technique for Teenagers – Training: Method of Self Control – **Empowerment of Mind**: Body, Soul and Mind – Bio Magnetism – Genetic Centre – Mind: Origin and its Ten Stages – Simplified Physical Exercises – **KayaKalpa Yoga**: Aim – Kayakalpa Philosophy – Importance of Kayakalpa Training – Training: Kaya Kalpa Yoga – **Meditation**: Introduction of Meditation – Benefits of Meditation – Training: Agna Meditation – Santhi Meditation.

Theory: 15 Hours	**Tutorial: -**	**Total: 15 Hours**

REFERENCES

1. Vethathiri's Maharishi's, "Yoga for Modern Age", The World Community Service Centre, Vethathiri Publications, 2009.
2. Vethathiri's Maharishi's, "Genetic Centre", The World Community Service Centre, Vethathiri Publications, 2003.
3. Vethathiri Maharishi's, "Rejuvenating Life Force and Mind" – paper–III for M.A. Yoga for Human Excellence", 3rd edition, The World Community Service Centre, Vethathiri Publications, 2010.
4. Swami Vivekananda, "Selections from the Complete Works", 23rd Edition, The Ramakrishna Mission Institute of Culture, 2007
5. Vethathiri's Maharishi's, "Mind", The World Community Service Centre, Vethathiri Publications, 1999.
6. Russell Kelfer, "Self Control", Tyndale House Publishers, 1985.
7. Dr. A. Chandra Mohan, "Leadership and Management", Himalaya Publication House.
8. Robert W. Bly, "Make Every Second Count", Career Press, Incorporated, 2010.
9. Vethathiri's Maharishi's, "Manavalakalai Part 1, 2 and 3", 11th Edition, The World Community Service Centre, Vethathiri Publications, 1994.
10. Swami Vivekananda, "Karma Yoga", 39th Edition, The Ramakrishna Mission Institute of Culture, 2008.

`

P20CAC0206	**DATA ANALYTICS**

Course Outcomes

After successful completion of this course, the students should be able to

CO1: Analyze and interpret data using an ethically responsible approach.
CO2: Use appropriate models of analysis, assess the quality of input, derive insight from results, and investigate potential issues.
CO3: Interpret data findings effectively to any audience, orally, visually and in written formats

BASICS OF DATA ANALYTICS

Basic Analysis Techniques-Statistical Hypothesis Generation and Testing-Chi-Square Test – T – TestAnalysis of Variance-Correlation Analysis-Maximum Likelihood Test-Practice And Analysis With R-Data Analysis Techniques-Regression Analysis-Classification Techniques—Clustering-Association Rules Analysis-Practice and Analysis With R

Theory: 15 Hours	**Tutorial: -**	**Total: 15 Hours**

REFERENCES

1. Rajendra Akerkar **&** Priti Srinivas Sajja, Intelligent Techniques for Data Science Springer International Publishing 2016.
2. Big Data: "Analytics for Enterprise Class, Hadoop and Streaming Data", McGrawHill Publishing, 2012.