B.E. COMPUTER SCIENCE AND ENGINEERING

REGULATION – 2021

AUTONOMOUS SYLLABUS

CHOICE BASED CREDIT SYSTEM

V TO VI SEMESTER CURRICULUM AND SYLLABI

VISION:

> To make the Department of Computer Science and Engineering the unique of its kind in the field of Research and Development activities in this part of world.

MISSION:

> To impart highly innovative and technical knowledge to the urban and unreachable rural student folks in Computer Science and Engineering through "Total Quality Education".

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

PEO 1: Apply the necessary mathematical tools and fundamental knowledge of computer science & engineering to solve variety of engineering problems.

PEO 2: Develop software based solutions for real life problems and be leaders in their profession with social and ethical responsibilities.

PEO 3: Pursue life-long learning and research in selected fields of computer science & engineering and contribute to the growth of those fields and society at large.

PROGRAM OUTCOMES:

After going through the four years of study, the Computer Science and Engineering graduates will have the ability to

POs	Graduate Attribute	Programme Outcome
1	Engineering knowledge	Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2	Problem analysis	Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3	Design/Development of solutions	Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4	Conduct investigations of complex 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, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations
6	The engineer and society	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice

7	Environment and sustainability	Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8	Ethics	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9	Individual and team work	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10	Communication	Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11	Project management and finance	Demonstrate knowledge and understanding of the engineering 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.
12	Life-long learning	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAMME SPECIFIC OUTCOMES (PSOs):

PSO1 : Professional Skills: The ability to understand, analyze and develop computer programs in the areas related to algorithms, system software, multimedia, web design, big data analytics, and networking for efficient design of computer-based systems of varying complexity.

PSO2 : Problem - Solving Skills: The ability to apply standard practices and strategies in software project development using open-ended programming environments to deliver a quality product for business success.

REGULATION - 2021

CHOICE BASED CREDIT SYSTEM

B.E. COMPUTER SCIENCE AND ENGINEERING

CURRICULUM AND SYLLABI FOR SEMESTER V TO VI

SEMESTER V

S.NO.	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	CS2301	Internet Programming	PC	3	3	0	0	3
2	CS2302	Introduction to Internet of Things	PC	3	3	0	0	3
3	CS2303	Machine Learning Techniques$^{#}$	PC	4	2	0	2	3
4	CS2304	Networking Essentials	PC	3	3	0	0	3
5		Professional Elective I	PE	-	-	-	-	3
6		Professional Elective II	PE	-	-	-	-	3
PRACTICALS								
7	CS2305	Computer Networks Laboratory	PC	4	0	0	4	2
8	CS2306	Internet of Things Laboratory	PC	4	0	0	4	2
9	CS2307	Internet Programming Laboratory	PC	4	0	0	4	2
10	EM2301	Internship**	EM	0	0	0	0	1
			TOTAL	-	-	-	-	25

 # Theory cum Laboratory Course

** Credits earned by the students through Internship will be given in the final consolidated mark statement.

SEMESTER VI

S.NO.	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	CS2351	Theory of Computation and Compiler Design	PC	3	3	0	0	3
2		Professional Elective III	PE	-	-	-	-	3
3		Professional Elective IV	PE	-	-	-	-	3
4		Professional Elective V	PE	-	-	-	-	3
5		Professional Elective VI	PE	-	-	-	-	3
6		Open Elective – I*	OE	3	3	0	0	3
PRACTICALS								
7	CS2352	Mini project	EEC	3	0	0	3	1
8	EM2351	Professional Communication	EM	2	0	0	2	1
			TOTAL	-	-	-	-	20

* Open Elective Shall be chosen from the list of open electives offered by other Programmes

VERTICALS

Verticals /Courses	Artificial Intelligence and Data Analytics	Software Application Development	Cyber Physical systems	Creative Media
1	Robotic Process Automation	Agile Project Development with Scrum	Ethical Hacking	Multimedia Systems
2	Deep Learning#	Software Testing and Quality Assurance	Principles of Cyber Security	Image Processing
3	Image Analytics and Computer Vision#	Rest Frame work for Business Applications#	DevOps for Cloud#	Game Design Techniques#
4	Big Data Systems#	Full Stack Development#	Blockchain Technologies#	Graphics Modeling and Simulation
5	Natural Language Processing Essentials#	Application Development using Flutter#	Virtualization and Cloud Computing#	Visual Effects
6	Information Retrieval Techniques	UI UX Design#	Multicore Architecture	Emerging Advancements in Augmented Reality and Virtual Reality#
7	Data Visualization#	C# and .Net Fundamentals#	Distributed Systems	Digital Marketing Essentials

 # Theory cum Laboratory Course

ARTIFICIAL INTELLIGENCE AND DATA ANALYTICS

S.NO.	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	VCS311	Robotic Process Automation	PE	3	3	0	0	3
2	VCS312	Deep Learning#	PE	4	2	0	2	3
3	VCS313	Image Analytics and Computer Vision#	PE	4	2	0	2	3
4	VCS314	Big Data Systems#	PE	4	2	0	2	3
5	VCS315	Natural Language Processing Essentials#	PE	4	2	0	2	3
6	VCS316	Information Retrieval Techniques	PE	3	3	0	0	3
7	VCS317	Data Visualization#	PE	4	2	0	2	3

 # Theory cum Laboratory Course

SOFTWARE APPLICATION DEVELOPMENT

S.NO.	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	VCS321	Agile Project Development with Scrum	PE	3	3	0	0	3
2	VCS322	Software Testing and Quality Assurance	PE	3	3	0	0	3
3	VCS323	Rest Frame work for Business Applications#	PE	4	2	0	2	3
4	VCS324	Full Stack Development#	PE	4	2	0	2	3
5	VCS325	Application Development using Flutter#	PE	4	2	0	2	3
6	VCS326	UI UX Design#	PE	4	2	0	2	3
7	VCS327	C# and .Net Fundamentals#	PE	4	2	0	2	3

 # Theory cum Laboratory Course

CYBER PHYSICAL SYSTEMS

S.NO.	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	VCS331	Ethical Hacking	PE	3	3	0	0	3
2	VCS332	Principles of Cyber Security	PE	3	3	0	0	3
3	VCS333	DevOps for Cloud#	PE	4	2	0	2	3
4	VCS334	Blockchain Technologies#	PE	4	2	0	2	3
5	VCS335	Virtualization and Cloud Computing#	PE	4	2	0	2	3
6	VCS336	Multicore Architecture	PE	3	3	0	0	3
7	VCS337	Distributed Systems	PE	3	3	0	0	3

 # Theory cum Laboratory Course

CREATIVE MEDIA

S.NO.	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	VCS341	Multimedia Systems	PE	3	3	0	0	3
2	VCS342	Image Processing	PE	3	3	0	0	3
3	VCS343	Game Design Techniques#	PE	4	2	0	2	3
4	VCS344	Graphics Modeling and Simulation	PE	3	3	0	0	3
5	VCS345	Visual Effects	PE	3	3	0	0	3
6	VCS346	Emerging Advancements in Augmented Reality and Virtual Reality#	PE	4	2	0	2	3
7	VCS347	Digital Marketing Essentials	PE	3	3	0	0	3

 # Theory cum Laboratory Course

OPEN ELECTIVE (CSE)

SL. NO.	OPEN ELEC TIVE	COURSE CODE	COURSE NAME	CATE GORY	CONTACT PERIODS	L	T	P	C
1	I	OCS781	Fundamentals of Software Engineering	OE	3	3	0	0	3

MINOR DEGREE – DEPARTMENT LEVEL – COMPUTING TECHNOLOGY

S.NO.	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
1	MCS101	Fundamentals of Data Structures	OE	3	3	0	0	3
2	MCS102	Database Essentials	OE	3	3	0	0	3
3	MCS103	Fundamentals of JAVA Programming	OE	3	3	0	0	3
4	MCS104	Introduction to Data Science	OE	3	3	0	0	3
5	MCS105	Artificial Intelligence and Machine Learning	OE	3	3	0	0	3
6	MCS106	Cloud Computing and its Applications	OE	3	3	0	0	3
7	MCS107	Software Engineering Essentials	OE	3	3	0	0	3
8	MCS108	Software Project Management Techniques	OE	3	3	0	0	3

Course Code	Course Name	L	T	P	C
CS2301	INTERNET PROGRAMMING	3	0	0	3

Category: Professional Core Course

a. Preamble

This course enables the students to understand the basic concepts of web development. The students get familiarized with the markup and coding involved in web development. This course focuses on different web programming languages, webservers and clients.

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Build responsive web pages using HTML, CSS	K3
CO2	Develop dynamic and interactive web pages by embedding JavaScript in HTML	K3
CO3	Construct server side web applications using JSP, Java servlets	K3
CO4	Apply PHP and DB concepts to develop interoperable web Applications	K3
CO5	Construct web applications using lightweight data-interchange format	K3

c. Course Syllabus **Total : 45 Periods**

WEB ESSENTIALS **9**

Internet - Internet Protocol Address - Domain Names - World Wide Web - Web Browsers - Web Servers-HTTP Message Structure – HTML5 – Tables – Lists – Images - HTML5 control, Semantic, Media controls – HTML APIs – HTML graphics elements - CSS3 – Inline, embedded and external style sheets – Rule cascading- Backgrounds – Border Images – Colors.

CLIENT SIDE SCRIPTING **9**

Client side scripting basics - An introduction to JavaScript–JavaScript DOM Model - Date and Objects- Built-in objects - Regular Expressions - Validation, built-in objects- Exception Handling, Event Handling - DHTML with JavaScript – JavaScript frameworks.

SERVER SIDE SCRIPTING **9**

Servlets: Java Servlet Architecture - Servlet Life Cycle- Form GET and POST actions- Session Handling- Understanding Cookies - Database Connectivity: JDBC perspectives, JDBC program -JSP: Understanding Java Server Pages - Creating HTML forms by embedding JSP code – JSP Standard Tag Library (JSTL).

PHP **9**

An introduction to PHP - Variables - Program control – Arrays - Built-in functions – Graphics – Form Validation- Regular Expressions - File handling – Cookies - Connecting to Database – Database operations - Email basics.

XML AND JSON **9**

Basics of XML - Document Type Definition - XML Schema - XML Parsers and Validation- JSON introduction - Syntax - Function – Files - AJAX: Ajax Client Server Architecture – XML response – JSON response – text file response - Retrieve Database Information.

d. Activities

Students shall be exposed to the web development concepts using simple applications.

e. Learning Resources

  Text Book

1. Deitel, Deitel and Nieto, *Internet and World Wide Web - How to Program*, 5th Edition, Prentice Hall, 2018.

  Reference Books

1. Chris Bates, *Web Programming – Building Intranet Applications*, 3rd Edition, Wiley Publications, 2009.

2. Jeffrey C and Jackson, *Web Technologies A Computer Science Perspective*, Pearson Education, 2011.

3. Uttam K Roy, *Web Technologies*, Oxford University Press, 2011.

Course Code	Course Name	L	T	P	C
CS2302	**INTRODUCTION TO INTERNET OF THINGS**	**3**	**0**	**0**	**3**

Category: Professional Core Course

a. Preamble

This course enables the students to understand the importance of Internet of Things and to solve the real-time challenges. This course enriches the logical skills and focuses on embedded projects.

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Outline the IoT architecture and sensor fundamentals.	K2
CO2	Explain the various protocols used in IoT applications.	K2
CO3	Build IoT Systems using Arduino, Esp8266 and Jetson Nano Developer kit.	K3
CO4	Develop IoT applications with Raspberry PI.	K3
CO5	Construct real time smart IoT Application using embedded	K3

c. Course Syllabus   **Total : 45 Periods**

INTRODUCTION TO IoT   **9**

Evolution of Internet of Things - IoT Enabling Technologies - IoT Levels - IoT Architectures - IoT and M2M – Classification of Sensors, Motion Sensors – Potentiometer, Bluetooth, Ultrasonic Ranging.

IoT PROTOCOLS   **9**

IoT Access Technologies: Physical and MAC Layers, Topology – Application layer protocols: CoAP and MQTT - Design Methodology - Embedded Computing Logic - Microcontroller, System on Chips - IoT System Building Blocks.

BUILDING IoT WITH ARDUINO, ESP8266 & JETSON   **9**

Arduino - Board Details, IDE Programming –Logical Design using Python, ESP8266 WiFi Module, Introduction to Jetson Nano Developer Kit and its applications.

IoT APPLICATION WITH RASPBERRY Pi 9

Overview of Raspberry Pi – General-Purpose Input/Outputs – Sensors with Raspberry Pi – Actuators with Raspberry Pi –Web Server with Raspberry Pi – Raspberry Pi as a Database Server – Raspberry Pi Programming examples.

CASE STUDIES AND REAL WORLD APPLICATIONS 9

IoT Cloud Storage Models and Communication APIs - Cloud for IoT – Smart Agriculture - Power Utility Industry - Smart Grid - Smart and Connected Cities: Smart Lighting, Smart Parking, Smart Traffic Control and Commercial building automation.

d. Activities

Students shall be exposed to Internet of Things concepts and to solve simple problems using IoT.

e. Learning Resources

Text Book

1. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton & Jerome Henry, *IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things*, Cisco Press, 2017.

Reference Books

1. Arshdeep Bahga and Vijay Madisetti, *Internet of Things - A hands-on approach*, Universities Press, 2015.

2. Olivier Hersent, David Boswarthick and Omar Elloumi, *The Internet of Things - Key Applications and Protocols*, Wiley, 2012 (for Unit 2).

3. Adeel Javed, "*Building Arduino Projects for the Internet of Things Experiments with Real-World Applications*", Apress, 2016

4. https://developer.nvidia.com/embedded/learn/get-started-jetson-nano-devkit#next -projects

5. John C. Shovic, "*Raspberry Pi IoT Projects Prototyping Experiments for Makers*", Apress, 2016.

Course Code	Course Name	L	T	P	C
CS2303	**MACHINE LEARNING TECHNIQUES**	**2**	**0**	**2**	**3**

Category: Professional Core Course (Theory cum Lab)

a. Preamble

This course enables the students to understand the basics of Machine Learning techniques. This course focuses on the study of machine learning fundamentals with python programming language for supervised and unsupervised learning algorithms.

b. Course Outcomes (Theory)

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Explain the fundamental concepts of machine learning	K2
CO2	Apply various types of regression and tree based model algorithms	K3
CO3	Solve real time problems using various types of classification algorithms	K3
CO4	Choose the ensemble method to improve the efficiency of the algorithm	K3
CO5	Construct various clustering algorithms for a real time problem	K3

Course Outcomes (Laboratory)

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Apply various types of Regression algorithms for an application	K3
CO2	Construct the classifiers like decision tree, KNN for an application	K3
CO3	Implement Naïve Bayes, perceptron and SVM algorithms for a real time problem	K3
CO4	Construct Ensemble learning algorithms using Random Forest and Ada Boosting	K3
CO5	Experiment with various clustering algorithms for a real time problem	K3

c. Course Syllabus   **Total : 60 Periods**

MACHINE LEARNING FUNDAMENTALS   **6**

Types of Machine learning: Supervised learning- Unsupervised learning -Reinforcement Learning- Machine Learning Process - Curse of Dimensionality, Overfitting - Performance Measures: Confusion Matrix - Accuracy Metrics – Bias - Variance Tradeoff.

SUPERVISED LEARNING - REGRESSION AND TREE BASED MODELS   **6**

Linear Regression - Multivariate Regression - Logistic Regression - Decision Trees.

SUPERVISED LEARNING – CLASSIFICATION   **6**

Naive Bayes – KNN Classification - Neural Networks - Perceptron Learning - Support Vector Machines.

ENSEMBLE LEARNING   **6**

Ensemble Methods – Bagging - Stacking - Boosting - Adaptive Boosting - Random Forests.

UNSUPERVISED LEARNING   **6**

Partitional Clustering - Hierarchical Clustering - Density based Clustering.

LIST OF LABORATORY EXPERIMENTS   **30**

1. Implement the regression algorithms in order to fit data points. Select appropriate data set for your experiment and draw graphs

2. Develop a program to demonstrate the working of the decision tree based ID3 algorithm. Use an appropriate data set for building the decision tree and apply this knowledge to classify a new sample.

3. Develop a program to implement the naïve Bayesian classifier for a sample training data set stored as a .CSV file. Compute the accuracy of the classifier, considering few test data sets.

4. Develop a program to implement k-Nearest Neighbour algorithm to classify the given data set. Print both correct and wrong predictions.

5. Build an Artificial Neural Network by implementing the perceptron learning algorithm and support vector machine and test the same using appropriate data sets

6. Implement Bagging and boosting algorithms of ensemble learning using Random Forest and Ada boosting to classify the given data set.

7. Implement Partition clustering and Hierarchal clustering algorithms for a given data set

d. Activities

Students shall be exposed to python packages to solve simple problems.

e. Learning Resources

Text Books

1. Ethem Alpaydin, *Introduction to Machine Learning*, 4th Edition, Prentice Hall of India, 2020.

2. Stephen Marsland, *Machine Learning - An Algorithmic Perspective* 2nd Edition, CRC Press, 2015.

Reference Books

1. Christopher Bishop, *Pattern Recognition and Machine Learning*, Springer, 2006.

2. Kevin P. Murphy, *Machine Learning: A Probabilistic Perspective*, MIT Press, 2012.

3. Tom Mitchell, *Machine Learning*, McGraw-Hill, 2017.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

S.No.	Description of Equipment	Quantity Required
1.	Personal Computers (Intel Core i3, HDD 500 GB, 4 GB RAM)	30
2.	Printer	1
3.	Software: Python	30

Course Code	Course Name	L	T	P	C
CS2304	**NETWORKING ESSENTIALS**	**3**	**0**	**0**	**3**

Category: Professional Core Course

a. Preamble

This course enables the students to understand the basic concepts of layering in networks, topology and several communication devices. The students get familiarized with the functions of protocols of each layer of TCP/IP protocol suite. It is also used to understand the functions of network layer and various routing protocols. Also, it enables the students to describe various user services in a network.

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Explain the basic layers and its functions in computer networks	K2
CO2	Apply error detection and correction mechanisms in data Link layer for error free data transmission	K3
CO3	Demonstrate the use of various routing protocols and their strategies in the network	K2
CO4	Compare the functionalities of TCP & UDP protocols in the transport layer during data transmission	K2
CO5	Summarize the functionalities of various application layer protocols and their real time usage	K2

c. Course Syllabus   **Total: 45 Periods**

PHYSICAL LAYER   **9**

Introduction: OSI Model – TCP/IP architectures – Networking: Topology – Types – Devices: Hubs – Bridges – Switches – Routers and Gateways – Transmission Media – Performance: jitter – delay – throughput – bandwidth-delay product.

DATALINK LAYER   9

Layers: MAC and LLC – Link Layer Addressing: ARP – Services: Error Detection and Correction – DLC Services: Framing – Types of Frames – Flow and Error Control – HDLC – PPP – Ethernet – IEEE 802.11.

NETWORK LAYER   9

IP address: IPv4 and IPv6 – Transition from IPv4 and IPv6 – DHCP – Subnetting – Services: Routing - Distance Vector – RIP – Link State – OSPF – Inter domain – BGP – IP.

TRANSPORT LAYER   9

Services: Flow Control, Congestion Control – QoS - Port Addressing, Protocols: TCP and UDP, SCTP.

APPLICATION LAYER   9

Protocols: HTTP – DNS – SMTP – MIME – POP – IMAP3 – FTP – S-FTP – TELNET– SSH.

d. Activities

Students shall be exposed to the core concepts of computer network and its associated functionalities of layered architecture.

e. Learning Resources

Text Books

1. Behrouz A Forouzan, *Data Communications and Networking*, 6th Edition, TMH, 2022.

2. Larry L Peterson and Bruce S Davie, *Computer Networks: A Systems Approach*, 6th Edition, Morgan Kaufmann Publishers Inc, 2019.

Reference Books

1. William Stallings, *Data and Computer Communications*, 10th Edition, Pearson Education, 2013.

2. Ying-Dar Lin, Ren-Hung Hwang and Fred Baker, *Computer Networks: An Open Source Approach*, McGraw Hill, 2012.

Course Code	Course Name	L	T	P	C
CS2305	**COMPUTER NETWORKS LABORATORY**	0	0	4	2

Category: Professional Core Course

a. Preamble

This course enables the students to develop simple socket programs, implement and analyze various networks protocols, and use simulation tool to analyze the performance of various protocols.

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Utilize the basic networking commands for capturing and examining packets in live networks	K3
CO2	Apply bit stuffing and error correction algorithms in a client / server environment	K3
CO3	Analyse the performance of network routing protocols and transport layer services through simulation tools	K4
CO4	Build applications using TCP sockets and DNS using UDP sockets	K3
CO5	Analyse the performance of network routing protocols and transport layer services through simulation tools	K4

c. Course Syllabus   **Total: 60 Periods**

1. Learn to use commands like tcpdump, netstat, ifconfig, nslookup and traceroute. Capture ping and traceroute PDUs using a network protocol analyzer and examine.
2. Simulation of bit stuffing concept
3. Simulation of an error correction code.
4. Simulation of Distance Vector/ Link State Routing algorithm.
5. Performance evaluation of Routing protocols using Simulation tool.
6. Implementation of subnetting concepts
7. Write a HTTP web client program to download a web page using TCP sockets.

8. Applications using TCP sockets like:

- Echo client and echo server
- Chat
- File Transfer

9. Simulation of DNS using UDP sockets.

10. Write suitable code for simulating ARP /RARP protocols.

11. Study of Network simulator (NS) and simulation of Congestion Control Algorithms using NS.

12. Performance Evaluation of TCP/UDP using Simulation tool.

d. Learning Resources

Text Books

1. Behrouz A Forouzan, *Data Communications and Networking*, 6th Edition, TMH, 2022.

2. Larry L Peterson and Bruce S Davie, *Computer Networks: A Systems Approach*, 6th Edition, Morgan Kaufmann Publishers Inc, 2019.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

S. No.	Description of Equipment	Quantity Required
1.	Personal Computers (Intel Core i3, HDD 500 GB, 4 GB RAM)	30
2.	Printer	1
3.	For capturing packets : Wireshark Simulation Tools Preferred : NS2 / CISCO Packet Tracer Language preferred : C, Java, Python	30

Course Code	Course Name	L	T	P	C
CS2306	INTERNET OF THINGS LABORATORY	0	0	4	2

Category: Professional Core Course

a. Preamble

This course enables the students to develop simple hardware applications using Sensors, Actuators and Micro Controllers for real-time problems.

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Construct simple applications using sensors	K3
CO2	Build IoT applications using various sensors	K3
CO3	Build IoT applications using Arduino	K3
CO4	Develop IoT applications using ESP8266 and Raspberry PI processor	K3
CO5	Develop real time smart IoT Applications	K3

c. Course Syllabus   **Total : 60 Periods**

List of Experiments

1. Working with Basic Analog and Digital Sensors
    a. LED Display
    b. Intensity Measurements (Dawn to Dusk)
    c. Human Detection

2. Working with Advanced Analog and Digital Sensors
    a. Flex Sensor
    b. Wet Measurement-Soil Moisture Sensor
    c. Sound Control
    d. Load Monitoring

3. Implementation of IOT applications using Arduino
    a. Temperature and Humidity measurement
    b. Signal Variance - Potentiometer
    c. Fire alarm indication using Buzzer

4. Monitoring sensor values in real time using Arduino.

      a.   IR Temperature sensor

      b.   Gas leakage detection

      c.   RFID

5. Study of ESP8266 WIFI module and implement basic programming

      a.   Blink a LED

      b.   WiFi configuration

      c.   Distance Measure

6. Using ESP8266 WIFI module to transfer of the data from and to the cloud.

      a.   Smart Street Light System using LDR and IR Sensor

      b.   Soil Condition Monitoring

      c.   Human detection – PIR Sensor

7. Applications using Raspberry Pi

      a.   Blink a LED

      b.   Stepper Motor Control

8. Implementation of applications in Industrial IoT

      a.   Smart AC Controller System

      b.   Machine health monitoring

      c.   Measuring current using current sensor ACS712

9. Smart application development using Jetson controller

10. Mini project in IoT

d. Learning Resources

Reference Book

1.   Michael Margolis and Arduino Cookbook, *Recipes to Begin, Expand, and Enhance Your Projects,* 3rd Edition, O'Reilly Media, 2020.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

S. No.	Description of Equipment	Quantity Required
1.	Personal Computers (Intel Core i3, 500 GB, 4 GB RAM)	20
2.	Printer	1
3.	Software: Arduino IDE, Third Party Cloud API like Azure/ Think speak, Python	20

S. No.	Description of Equipment	Quantity Required
	Hardware list	
1.	Arduino Boards	10
2.	Node MCU	10
3.	Raspberry PI 4	10
4.	Jetson GPU Board	10

Course Code	Course Name	L	T	P	C
CS2307	**INTERNET PROGRAMMING LABORATORY**	0	0	4	2

Category: Professional Core Course

a. Preamble

The course has been designed to impart practical knowledge on Web application development to understand the need of different web programming languages to meet out users requirements. This course enables the students to develop web application for business, industries and educational institutions.

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Build dynamic web pages using HTML5, CSS3, JavaScript and its related frameworks	K3
CO2	Develop three-tier web applications using server-side scripting languages	K3
CO3	Construct simple web applications using PHP and Backend connectivity	K3
CO4	Develop interoperable web applications using XML and its related technologies	K3
CO5	Build web application for solving real world applications	K3

c. Course Syllabus   **Total: 60 Periods**

1. Develop a website using HTML5 tables, lists, control elements, media elements, graphics elements, Geo location, drag and drop effects, image maps.

2. Develop web pages with the following.

    a. Use different CSS selectors

    b. External style sheets.

    c. Embedded style sheets.

    d. Inline style sheets.

3. Construct and Validate the Registration, user login, user profile and payment by credit card forms using JavaScript.

4. Develop programs in Java using Servlets:
   a) To invoke servlets from HTML forms
   b) To track sessions using hidden form fields, URL rewriting techniques
   c) To track sessions for counting the number of visitors who visited the web page
5. Develop a three-tier web application using servlets. (Assume that related information is available in a database which has been stored in a database server)
   a) Online examination System.
   b) Library management System.
   c) Ticket reservation system, etc.
6. Develop a simple dynamic web application along with database connectivity using JSP and cookies.
7. Construct a PHP applications for the following:
   a) Validate the HTML forms using regular expressions
   b) Send an email
   c) Store form data into database
8. Construct an PHP application for reading data from XML and processing
9. Develop a web application for online shop using lightweight data-interchange format.

d. Learning Resources

Reference Book

1. Deitel, Deitel and Nieto, *Internet and World Wide Web - How to Program*, 5th Edition, Prentice Hall, 2018.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

S. No.	Description of Equipment	Quantity Required
1.	Hardware Requirements Personal Computers (Intel Core i3, 500 GB, 4 GB RAM)	30
2.	Printer	1
3.	Software Tools: Netbeans IDE, XAMPP	30

Course Code	Course Name	L	T	P	C
EM2301	**INTERNSHIP**	**0**	**0**	**0**	**1**

Category: Employability Enhancement Course

a. Preamble

To enable the students to

• Get connected with industry/ laboratory/research institute.

• Get practical knowledge on production process in the industry and develop skills to solve industry related problems.

• Develop skills to carry out research in the research institutes/laboratories.

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Validate system-level processes, techniques, manufacturing and production processes in the industry/research facilities of the laboratory/research institute.	K5
CO2	Analyse the solutions of industry/research problems.	K4
CO3	Document system specifications, design methodologies, process parameters, testing parameters and results.	K2
CO4	Comprehend the process followed in the industry/research institute in the form of presentation.	K2
CO5	Demonstrate the technical knowledge observed in the industry/research institute with the courses studied.	K2

c. Course Instruction

The students individually undergo training in reputed industry/ research institutes / laboratories for the specified duration. After completion of the training, a detailed report should be submitted within ten days from the commencement of next semester. The evaluation will be done as per the Regulations. Credits shall be awarded to the students who satisfy the clauses for industrial training/ internship of the Regulation concerned.

Course Code	Course Name	L	T	P	C
CS2351	**THEORY OF COMPUTATION AND COMPILER DESIGN**	3	0	0	3

Category: Professional Core Course

a. Preamble

This course enables the students to understand the importance of theory of computation in compiler design. This course focuses on designing computational models and lexical analyzers.

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Develop lexical analyser for a sample language	K3
CO2	Construct parser for a simple context free language	K3
CO3	Explain the key features of syntax-directed translation and intermediate codes	K2
CO4	Summarize the concepts of run-time environment and code generation	K2
CO5	Apply different code optimization techniques	K3

c. Course Syllabus   **Total : 45 Periods**

FORMAL LANGUAGE AND REGULAR EXPRESSIONS   **10**

Definition: Languages - regular expressions - Finite Automata: DFA - NFA - Conversion of regular expression to NFA - NFA to DFA - Structure of a compiler – Role of Lexical Analyzer – Input Buffering – Specification of Tokens - Recognition of Tokens - Lex tool.

CONTEXT FREE GRAMMARS AND PARSING   **10**

Context Free Grammars – Derivation - Parse trees – ambiguity - Role of Parser – Error Handling – Top down parsers – Predictive Parsing - Bottom up parsers - Handle pruning - LR Parsers – SLR - CLR - Error Handling and Recovery in Syntax Analyzer - YACC tool.

SEMANTICS AND INTERMEDIATE CODE GENERATION 9

Syntax Directed Definitions - Evaluation Orders for Syntax Directed Definitions, Intermediate Languages: Syntax Tree - Three Address Code - Types and Declarations - Translation of Expressions - Type Checking.

RUNTIME STORAGE AND CODE GENERATION 9

Storage Organization - Stack Allocation Space - Access to Non-local Data on the Stack - Heap Management - Issues in Code Generation - Design of a simple Code Generator.

CODE OPTIMIZATION 7

Principal Sources of Optimization – Peep-hole optimization – DAG - Optimization of Basic Blocks.

d. Activities

Students shall be exposed to theory of computation and compiler design concepts and to design computational models and analyzers.

e. Learning Resources

Text Book

1. Aho, Ullman and Ravi Sethi, *Compilers Principles, Techniques and Tools*, 2nd Edition, Pearson Education, 2009.

Reference Books

1. John E Hopcroft, Rajeev Motwani & Jeffrey D Ullman, *Introduction to Automata Theory Languages & Computation*, 3rd Edition, Pearson Education, 2007.
2. Tremblay JP and Sorenson GP, *The Theory & Practice of Compiler writing*, 1st Edition, BSP publication, 2010.

Course Code	Course Name	L	T	P	C
CS2352	**MINI PROJECT**	**0**	**0**	**3**	**1**

Category: Employability Enhancement Course

a. **Preamble**

This course develops the ability to solve a specific problem right from its identification and literature review till the successful solution of the same. It is used to train the students in preparing project reports and to face reviews and viva voce examination.

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Identify challenging engineering problems/Societal needs to propose project-based solutions	K3
CO2	Build critical-thinking and analytical decision-making capabilities to find solution by formulating proper methodology	K3
CO3	Analyze various algorithmic strategies using technological tools to provide software solutions	K4
CO4	Develop solutions to identified problems	K3
CO5	Build an independent project, resulting in at least a publication in reputed journals or conference proceedings	K3

TOTAL: 45 PERIODS

The students will be working in single or group of 3 to 4 on a scientific problem approved by the Head of the Department under the guidance of the faculty member and prepare a comprehensive report after completing the work to the satisfaction of the supervisor. The progress of the project is evaluated based on a minimum of three reviews. The review committee may be constituted by the Head of the Department. A project report is required at the end of the semester. The project work is evaluated based on project evaluation process as recommended in the respective regulation.

The student can also be permitted to work on the project in Industry/Research organization with the due permission from Head of the Department. The Engineer/Scientist from Industry/ Research Organization can jointly act as supervisor in addition to the Project Supervisor. The student should undergo project evaluation process as recommended in the respective regulation.

Course Code	Course Name	L	T	P	C
EM2351	**PROFESSIONAL COMMUNICATION**	**0**	**0**	**2**	**1**

Category: Employability Enhancement Courses

a. Preamble

The course aims to:

• Enhance the Employability and Career Skills of students.

• Orient the students towards grooming as a professional.

• Make them Employable Graduates.

• Develop their confidence and help them attend interviews successfully.

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Apply hard and soft skills to enhance their employability	K3
CO2	Utilize adequate presentation skills to present a PPT	K3
CO3	Demonstrate the proper usage of grammar in GD	K3
CO4	Make use of the acquired skills while attending interviews	K3
CO5	Develop adequate Soft Skills required for the workplace	K3

c. Course Syllabus   Total : 30 Periods

SOFT SKILLS   **6**

Introduction to Soft Skills– Hard skills & soft skills – employability and career Skills—Grooming as a professional with values—Time Management—General awareness of Current Affairs.

EFFECTIVE PRESENTATIONS   **6**

Self-Introduction-organizing the material – Introducing oneself to the audience – introducing the topic – answering questions – individual presentation practice— presenting the visuals effectively – 5 minute presentations.

GROUP DISCUSSION   6

Introduction to Group Discussion— Participating in group discussions – understanding group dynamics – brainstorming the topic -– questioning and clarifying –GD strategies-activities to improve GD skills.

INTERVIEW ETIQUETTE   6

Interview etiquette – dress code – body language – attending job interviews– telephone/skype interview -one to one interview &panel interview – FAQs related to job interviews.

CAREER PLAN   6

Recognizing differences between groups and teams- managing time-managing stress-networking professionally- respecting social protocols-understanding career management-developing a long-term career plan-making career changes.

d. Activities

Students shall be trained in Individual Presentation, Group Discussion and Mock Interview.

e. Learning Resources

Reference Books

1. Butterfield and Jeff, Soft *Skills for Everyone*, Cengage Learning: New Delhi, 2015.
2. Suresh Kumar E, *Communication for Professional Success,* Orient Blackswan: Hyderabad, 2015.
3. *Interact English Lab Manual for Undergraduate Students*, Orient BlackSwan: Hyderabad, 2016.
4. Raman, Meenakshi and Sangeeta Sharma, *Professional Communication*, Oxford University Press: Oxford, 2014.
5. Hariharan S, *Soft Skills*, MJP Publishers: Chennai, 2010.

Course Code	Course Name	L	T	P	C
VCS311	**ROBOTIC PROCESS AUTOMATION**	**3**	**0**	**0**	**3**

Category: Professional Elective Course

a. Preamble

This course enables the students to understand the Robotic Process Automation (RPA) and the ability to differentiate it from other types of automation and outline the benefits of RPA with the various platforms supported for automation. The students will be able to understand to store and manipulate data in a more persistent way using such files as CSV and Excel. They experiment with workflow in a manner to get the optimized output from a Bot.

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Describe the fundamental concepts of RPA and their benefits	K2
CO2	Illustrate the work flow sequence and control flow of UiPath	K2
CO3	Interpret the data manipulation in UiPath and File Operations	K2
CO4	Demonstrate various controls and exception strategies	K2
CO5	Develop simple bot applications with events handling	K3

c. Course Syllabus   **Total : 45 Periods**

INTRODUCTION TO ROBOTIC PROCESS AUTOMATION   **9**

Introduction - RPA vs Automation - Scope and techniques of automation - Purpose of RPA - Benefits of RPA - Components of RPA - RPA platforms- About UiPath - The future of automation.

UiPATH SEQUENCE AND CONTROL FLOW   **9**

UiPath Stack-Learning UiPath Studio-Task recorder - Sequencing the work flow – Activities-Control Flow-Various types of loops and decision making-Example.

DATA MANIPULATION   **9**

Variables and scope - Collections - Arguments purpose and use - Data table usage with examples - Clipboard Management - File operation with step by step example - CSV/Excel to data table and vice versa.

TAKING CONTROL OF THE CONTROLS 9

Finding and attaching windows - Finding the control - Techniques for waiting for a control - Act on control - Mouse and Keyboard activities - Working with UiExplorer - handling events - Revisit recorder - Screen Scraping - Usage of OCR - Types of OCR available - How to use OCR - Avoiding typical failure points.

HANDLING USER EVENTS AND ASSISTANT BOTS 9

Assistant bots - Monitoring system event triggers - Launching an assistant bot on a keyboard event - Deploying and Maintaining the Bot - Publishing using public utility - Overview of Orchestration Server - Using Orchestration Server to control bots -Using Orchestration Server to deploy bots - License management - Publishing and managing updates.

d. Activities

Students shall be exposed to the core concepts of Robotics Process Automation using case study.

e. Learning Resources

Text Books

1. Tom Taulli, *The Robotic Process Automation Handbook: A Guide to Implementing RPA System*, Apress, 2020.

2 Alok Mani Tripathi, *Learning Robotic Process Automation*, Packt Publishing, 2018.

Reference Books

1. Nandan Mullakara and Arun Kumar Asokan, *Robotic Process Automation Projects: Build real-world RPA solutions using UiPath and Automation Anywhere*, Packt Publishing, 2020.

2. Frank Casale, Rebecca Dilla, Heidi Jaynes and Lauren Livingston, *Introduction to Robotic Process Automation: a Primer*, 1st Edition , Institute of Robotic Process Automation, 2015.

3. Lim Mei Ying, *Robotic Process Automation with Blue Prism Quick Start Guide: Create software robots and automate business processes*, 1st Edition, Packet Publishing, 2018.

4. Srikanth Merianda, *Robotic Process Automation Tools, Process Automation and their benefits: Understanding RPA and Intelligent Automation*, 1st Edition, Consulting Opportunity Holdings LLC, 2018.

Course Code	Course Name	L	T	P	C
VCS312	**DEEP LEARNING**	**2**	**0**	**2**	**3**

Category: Professional Elective Course (Theory cum Lab)

a. Preamble

This course enables the students to understand the concepts of neural networks. This course aims to provide students with knowledge in deep learning models with Convolutional Neural Network. This course focuses on solving real-world applications using deep learning techniques.

b. Course Outcome (Theory)

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Explain the fundamental concepts of deep learning and neural networks	K2
CO2	Illustrate the optimization algorithms used to train Recurrent Neural Network (RNN) models such as Long Short Term Memory (LSTM) and Gated Recurrent Units (GRUs)	K2
CO3	Apply Convolutional Neural Network (CNN) models, like LeNet, for image classification tasks	K3
CO4	Construct modern Convolutional Neural Network (CNN) architectures for various computer vision tasks, such as object detection and voice recognition	K3
CO5	Develop and train deep Reinforcement Learning (RL) and generative models on various data sources and tasks	K3

Course Outcome (Lab)

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Construct a feed forward neural networks and understand the role of activation functions	K3
CO2	Develop and train Recurrent Neural Networks (RNNs) for Natural Language Processing (NLP) tasks with optimization algorithms	K3
CO3	Construct deep learning models to various real-world applications, including image recognition and speech recognition	K3
CO4	Identify transfer learning techniques to adapt pre-trained Convolutional Neural Network (CNN) models like VGG for new tasks	K3
CO5	Apply deep reinforcement learning and generative models together to build complex systems that can learn and generate behaviors	K3

c.   Course Syllabus   **Total : 60 Periods**

DEEP LEARNING FUNDAMENTALS   **6**

Artificial Intelligence, Machine Learning and Deep Learning - Need for Deep Learning - Data Representations for Neural Networks - Activation functions - Linear Neural Networks: Regression and Classification - Perceptron - Deep learning applications.

RECURRENT NEURAL NETWORKS   **6**

Recurrent Neural Networks Architecture - Back propagation process - Long Short Term Memory (LSTM) - Gated Recurrent Units (GRU) - Deep Recurrent Neural Network - Bidirectional Recurrent Neural Network - Optimization Algorithms - Applications of RNN.

CONVOLUTIONAL NEURAL NETWORKS   **6**

Layers in CNN architecture - Convolutions - Padding - Stride - Multiple Input and Multiple Output Channels - Pooling - Convolutional Neural Networks (LeNet).

MODERN CONVOLUTIONAL NEURAL NETWORKS 6

Deep Convolutional Neural Networks - Networks using Blocks - Network in Network - Multi Branch Networks - Batch Normalization - Residual Networks - Densely Connected Networks - Applications of CNN

GENERATIVE, REINFORCEMENT DEEP LEARNING 6

Generative deep learning - Variational auto encoders - Reinforcement Learning - Generative Adversarial Networks - Natural Language Processing applications.

30

LIST OF LABORATORY EXPERIMENTS

Implement the following using Python and Tensor Flow

1. Apply the Perceptron training algorithm for AND or OR gates.
2. Develop and train Long Short Term Memory (LSTM) models for sequence prediction problems and evaluate the performance of the network.
3. Build and train a model to predict the category of an animal using Convolutional Neural Network (CNN).
4. Construct a Convolutional Neural Network (CNN) model for an audio analysis problem. Train a CNN to classify the audio files into appropriate categories based on their features.
5. Construct a Visual Geometry Group (VGG) model for a binary classification task.
6. Develop and train a Variational Auto Encoder (VAE) on the MNIST dataset to generate new images of handwritten digits.
7. Mini Project

d. Activities

Students shall be exposed to the Deep Learning concepts using case study.

e. Learning Resources

Text Book

1. Zhang A, Lipton ZC, Li M and Smola AJ, *Dive into deep learning*, arXiv preprint arXiv:2106.11342, 2021.

Reference Books

1. Francois Chollet, *Deep Learning with Python*, Manning Publications, New York, *2018*.

2. Lovelyn Rose S, Ashok Kumar L and Karthika Renuka D, *Deep Learning using Python*, Wiley India Pvt. Ltd., New Delhi, 2019.

3. Thomas Farth, *Deep Learning: A Comprehensive Guide for Beginners*, Atlantic Publishers, 2019.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

S.No.	Description of Equipment	Quantity Required
1.	Personal Computers (Intel Core i3, 500GB, 4 GB RAM)	30
2.	Printer	1
3.	Software: Python packages - Numpy, Pandas, Matplotlib, Sklearn, Scipy, Keras, Tensor flow, Pytorch and Pyspark	30

Course Code	Course Name	L	T	P	C
VCS313	**IMAGE ANALYTICS AND COMPUTER VISION**	2	0	2	3

Category: Professional Elective Course (Theory cum Lab)

a. Preamble

This course enables the students to learn image processing techniques for computer vision. This course enriches the students in image processing concepts like histograms, geometric transformations, edge detection, features and recognition techniques. This course focuses on real time problems like video tracking and image panoramas.

b. Course Outcome (Theory)

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Explain fundamental image processing techniques required for computer vision	K2
CO2	Explain histogram and thresholding techniques	K2
CO3	Apply edge detection and geometric transformations on images	K3
CO4	Apply feature extraction techniques on images	K3
CO5	Develop image panorama and video tracking	K3

Course Outcome (Lab)

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Experiment with fundamental image processing techniques	K3
CO2	Apply image enhancement using histograms and image smoothing, sharpening techniques on images	K3
CO3	Apply geometric transformations, morphological operations on images	K3
CO4	Make use of edge detection and feature extraction techniques	K3
CO5	Develop applications using moving object detection, image panorama and classification concepts	K3

c. Course Syllabus   **Total : 60 Periods**

BASIC OPERATIONS ON IMAGES USING OPENCV   **6**

History of OpenCV - Displaying Images from Disk in a Window - The cv::Mat Structure - Converting Between Colorspaces - Circle and Line Detection - Image Inpainting - GUI TrackBars and Callback Functions – ROI.

HISTOGRAM AND THRESHOLDING   **6**

Noise – Smoothing - 1D and 3D histograms - Histogram/Image Equalisation - Histogram Comparison - Thresholding - Threshold Detection Methods - Variations on Thresholding - Mathematical Morphology-Connectivity.

GEOMETRIC TRANSFORMATIONS AND EDGES   **6**

Problem Specification and Algorithm -Affine Transformations - Perspective Transformations- Specification of More Complex Transformations– Interpolation - Edge Detection - Hough Transform.

FEATURES AND RECOGNITION   **6**

Moravec Corner Detection - Harris Corner Detection - FAST Corner Detection - SIFT - Template Matching - Chamfer Matching - Statistical Pattern Recognition - Cascade of Haar Classifiers – YOLO Algorithm - Performance.

VIDEO AND PANORAMAS   **6**

Moving Object Detection – Tracking - Video Datasets and Formats - Metrics for Assessing Video Tracking Performance - Image panorama.

LIST OF LABORATORY EXPERIMENTS   **30**

   Implement the following using OpenCV
   1.   Your client has provided you with a 24-bit color image that needs to be converted to an 8-bit image,4-bit image and 1-bit image but they have requested that the image's overall color balance and contrast remain unchanged.
   2.   You are working with a team to develop a photo editing application and one of the features you need to implement is the ability to convert between color-spaces on the fly.
   3.   You have a digital camera that captures images in the RAW format, which has a higher dynamic range than most display devices can show. Implement histogram equalization, stretching to improve the contrast of these images and histogram mapping to adjust the exposure and dynamic range of these images so that they can be displayed on a standard monitor.

4. Your client has provided you with a set of images that have been captured using a low-quality camera. They want you to smoothing out the rough edges and also sharpen the edges.

5. Your lab has been tasked with creating a program that can scale, rotate, translate and shear an image. The program needs to be able to handle images of different sizes and aspect ratios.

6. You have a binary image that contains small gaps, specks and noise in the foreground. Implement dilation and closing on the image to fill in these gaps to create a continuous foreground, erosion to remove specks and opening to remove noise.

7. Given an image of a handwritten letter, implement edge detection to highlight the edges of the letter.

8. You have a dataset of images of different animal faces. Implement feature extraction to identify the unique features of each animal's face.

9. You have a video stream from a surveillance camera overlooking a parking lot. Implement moving object detection to identify cars entering and exiting the parking lot.

10. You have a series of images taken from a drone flying over a city. Use image panorama to stitch these images together to create a high-resolution map of the city.

11. You are working on a project to develop an image classification system that can identify different types of animals in images. The dataset contains images of various animals, including dogs, cats, and birds. Your task is to annotate each image with the corresponding animal label.

d. Activities

Students shall be exposed to image processing concepts and to solve simple problems using OpenCV.

e. Learning Resources

Text Books

1. Kenneth Dawson-Howe, *A Practical Introduction to Computer Vision with OpenCV*, Wiley, 2014.

2. Samarth Brahmbhatt, *Practical OpenCV*, Apress, 2013.

Reference Books

1. Adrian Kaehler and Gary Bradski, *Learning OpenCV 3: Computer Vision in C++ with the OpenCV Library*, 1st Edition, O'Reilly Media, 2017.

2. Prateek Joshi, David Millán Escrivá and Vinicius Godoy, *OpenCV by Example*, Packt Publishing, 2016.

3. Adrian Rosebrock, *Practical Python and OpenCV*, 2nd Edition, Py Image Search, 2016.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

S.No.	Description of Equipment	Quantity Required
1.	Personal Computers (Intel Core i3, 500GB, 4 GB RAM)	30
2.	Printer	1
3.	Software: OpenCV	30

Course Code	Course Name	L	T	P	C
VCS314	BIG DATA SYSTEMS	2	0	2	3

Category: Professional Elective Course (Theory cum Lab)

a. Preamble

The course enables the students to understand Big Data processing used in different business intelligence applications and provide an in-depth coverage of Map Reduce analytics using Hadoop Eco system tools. The students will gain programming knowledge in Pig, Hive, Hbase to handle the Big Data applications and they will get exposure in blooming Big Data technologies.

b. Course Outcome (Theory)

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Explain the fundamental concepts of Big Data tools and techniques	K2
CO2	Apply map reduce algorithms in Hadoop framework	K3
CO3	Construct NoSQL data models for the appropriate databases	K3
CO4	Develop scripts using Pig Latin	K3
CO5	Build HiveQL queries for data analytics	K3

Course Outcome (Lab)

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Build the file management tasks in Hadoop	K3
CO2	Solve problems using MapReduce	K3
CO3	Construct NoSQL data models for the appropriate databases	K3
CO4	Develop scripts using Pig Latin	K3
CO5	Develop DDL and DML commands using HiveQL	K3

c. Course Syllabus   **Total : 60 Periods**

INTRODUCTION TO BIG DATA   **6**

Introduction - Types of Digital Data - Characteristics of BigData - 3Vs of Big Data - Evolution of Big Data - Architecture of Big Data systems - Advantages of Big Data - Challenges with Big Data - Big Data Use Cases -Analytics – Descriptive Analytics – Diagnostic Analytics – Predictive Analytics – Prescriptive Analytics

DATA ANALYTICS USING HADOOP AND MAPREDUCE
FRAMEWORK   **6**

Introduction to Hadoop - RDBMS versus Hadoop - Hadoop Overview - HDFS (Hadoop Distributed File System) - Processing Data with Hadoop - Introduction to MapReduce - Features of MapReduce - Algorithms Using MapReduce: Matrix-Vector Multiplication, Relational Algebra Operations, Grouping and Aggregation - Extensions to MapReduce.

NOSQL DATA MANAGEMENT FOR BIG DATA   **6**

NoSQL Databases - CAP Theorem - BASE Concept –- NoSQL data Models - Increasing Flexibility for Data Manipulation-Key Value Stores - Document Stores - Tabular Stores - Object Data Stores - Graph Databases - Hive – Sharding - Hbase

DATA ANALYTICS USING PIG   **6**

Introduction - Installation and Execution - Pig Data Model - Pig Latin - Input, Output- Relational Operators - User Defined Functions - Join Implementations - Integrating Pig with Legacy Code and Map Reduce - Developing and Testing Pig Latin Scripts

DATA ANALYTICS USING HIVE   **6**

Introduction - Data Types and File Formats - Databases in Hive – HiveQL - Data Definition - Data Manipulation - Queries - Views - Indexes - Schema Design

LIST OF LABORATORY EXPERIMENTS   **30**

1.   (i) Installation of Hadoop in two operating modes:

        - Pseudo distributed,
        - Fully distributed.

        (ii) Monitoring Hadoop setup using web based tools

2.   (i) Implementation of file management tasks in Hadoop

        (ii) Benchmark and stress test on Apache Hadoop cluster

3. Implementation of Word Count Map Reduce program

   (i) Finding the number of occurrences of each word appearing in the input file(s)

   (ii) Perform a MapReduce Job for word search count (look for specific keywords in a file).

4. Implementation of stop word elimination problem using MapReduce

5. Implementation of HBase queries in NOSQL

6. Installation of Pig on Hadoop

7. Development of Pig Latin scripts to sort, group, join, project and filter data

8. Installation of Hive

9. DDL and DML commands using HiveQL

10. Mini Project

d. Activities

Students shall be exposed to programming knowledge in Hadoop, MapReduce, Pig, Hive to handle the Big Data applications

e. Learning Resources

Text Books

1. David Dietrich, Barry Heller and Beibei Yang, *Data Science and Big data Analytics*, EMC, 2013.

2. Seema Acharya and Subhasini Chellappan, *Big Data and Analytics*, Wiley Publication, 2015.

3.. Raj Kamal and Preeti Saxena, *Big Data Analytics: Introduction to Hadoop, Spark, and Machine-Learning*, McGraw Hill, 2018.

4. Tom White, *Hadoop: The Definitive Guide*, 3rd Edition, O'reily Media, 2015.

5. EMC Education Services, *Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data*, 2015.

Reference Books

1. Mark Van Rijmenam, *Think Bigger: Developing a Successful Big Data Strategy for Your Business*, Amazon, 1st Edition, 2014.

2. Hurwitz JS, Nugent A, Halper F & Kaufman M, *Big data for dummies*, John Wiley & Sons, 2013.

3. Bill Franks, *Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics,* John Wiley & sons, 2012.

4. Jure Leskovec, Anand Rajaraman and Jeffrey Ullman, *Mining of Massive Datasets,* Cambridge University Press, 2020.

5. Alan Gates and Daniel Dai, *Pig: Data flow Scripting with Hadoop,* O'Reilly Media, 2016.

6. Jason Rutherglen, Dean Wampler and Edward Capriolo, *Programming Hive,* 1st Edition, O'Reilly Media, 2012.

7. Dayong Du, *Apache Hive Essentials*, Packet Publishing, 2015.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

S.No.	Description of Equipment	Quantity Required
1.	Personal Computers (Intel Core i3, 500GB, 6 GB RAM)	30
2.	Java	30
3.	Hadoop	30
4.	Big data tools - Pig Latin, Hive, HBase	30

Course Code	Course Name	L	T	P	C
VCS315	**NATURAL LANGUAGE PROCESSING ESSENTIALS**	**2**	**0**	**2**	**3**

Category: Professional Elective Course (Theory cum Lab)

a. Preamble

This course enables the students to explore word level analysis. The students get familiarized with the use of Context Free Grammar (CFG) in NLP and the role of semantics and pragmatics. This course also focuses on discourse analysis.

b. Course Outcome (Theory)

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Explain the fundamental concepts of Natural Language Processing	K2
CO2	Illustrate the algorithms used in word level analysis	K2
CO3	Demonstrate the use of CFG in syntactic analysis	K2
CO4	Outline the need for semantics and pragmatics	K2
CO5	Interpret the context of the discourse using coherence	K2

Course Outcome (Lab)

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Apply various preprocessing steps to a given sentence	K3
CO2	Make use of the algorithms in word level analysis	K3
CO3	Identify the need for semantics and pragmatics	K3
CO4	Apply Lesk Algorithm for word disambiguation	K3
CO5	Develop a conversational agent with simple dialog	K3

c. Course Syllabus   **Total: 60 Periods**

INTRODUCTION   6

Origins and challenges of NLP – NLP applications - Regular Expression basics –Corpora - Preprocessing - Text tokenization – Stemming – Lemmatization – Removing stop-words- Minimum Edit Distance - Sign language basics

WORD LEVEL ANALYSIS   6

Unsmoothed N-grams, Evaluating N-grams, Smoothing, Interpolation and Backoff – Word Classes - Part-of-Speech Tagging -Named Entities and Named Entity Tagging - Evaluation of Named Entity Recognition

SYNTACTIC ANALYSIS   6

Context-Free Grammars, Treebanks, Grammar Equivalence and Normal Form – Ambiguity- CKY parsing –Span-Based Neural Constituency Parsing - Evaluating Parsers

SEMANTICS AND PRAGMATICS   6

Word Senses - Relations between Senses– WordNet - Word Sense Disambiguation (WSD) –WSD algorithms and Tasks -Thesauruses to Improve Embeddings - Word Sense Induction

DISCOURSE ANALYSIS   6

Coherence Relations - Discourse Structure Parsing - Centering and Entity-Based Coherence - Representation learning models for local coherence - Global Coherence

LIST OF LABORATORY EXPERIMENTS   30

1. Create Regular expressions for detecting word patterns and tokenizing text
2. Getting started with Python and NLTK -Preprocessing –stop word removal and stemming
3. Implement N-gram tagging
4. Implement N-gram smoothing
5. Implementation of part-of- speech tagging
6. Implementation of chunking
7. Implementation of word similarity
8. Implementation of Lesk Algorithm for word disambiguation
9. Design a chatbot with a simple dialog system

d. Activities

Students shall be exposed to the core concepts of Natural Language Processing using case study.

e. Learning Resources

Text Book

1. Daniel Jurafsky and James H Martin, *Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech Recognition*, 3rd Edition, Pearson Publication, 2023.

Reference Books

1. Tanveer Siddiqui and Tiwary US, *Natural Language Processing and Information Retrieval*, Oxford University Press Reprint, 2023.

2. Richard MReese, *Natural Language Processing with Java*, O'Reilly Media, 2015.

3. Nitin Indurkhya and Fred J Damerau, *Handbook of Natural Language Processing*, 2nd Edition, Chapman and Hall/CRC Press, 2010.

4. Steven Bird, Ewan Klein and Edward Loper, *Natural Language Processing with Python*, 1st Edition, O_Reilly Media, 2009.

5. Breck Baldwin, *Language Processing with Java and LingPipe Cookbook*, Atlantic Publisher, 2015.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

S. No.	Description of Equipment	Quantity Required
1.	Personal Computers (Intel Core i3, 500 GB, 4 GB RAM)	30
2.	Printer	1
3.	Software: Python with NLTK package	30

Course Code	Course Name	L	T	P	C
VCS316	**INFORMATION RETRIEVAL TECHNIQUES**	3	0	0	3

Category: Professional Elective Course

a. Preamble

This course enables the students to understand the basic concepts about information retrieval, machine learning techniques, text classification, clustering and web retrieval. The students get familiarized with web crawler, scheduling algorithms and evaluation process. This course focuses on various retrieval algorithms and recommender systems and their techniques useful for a real time user.

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Explain the architectural design and basic concepts of Information Retrieval	K2
CO2	Identify the suitable search engine model to retrieve documents	K3
CO3	Apply machine learning techniques to text classification and clustering which is used for efficient information retrieval	K3
CO4	Outline several search engine architecture operations, crawling, and indexing principles for web search	K2
CO5	Demonstrate characteristics and potentials of different prediction techniques in recommender systems	K2

c. Course Syllabus   **Total : 45 Periods**

INTRODUCTION   **9**

Information Retrieval – Early Developments – The IR Problem – The User's Task – Information versus Data Retrieval – The IR System – The Software Architecture of the IR System – The Retrieval and Ranking Processes – The Web – The e-Publishing Era – How the web changed Search – Practical Issues on the Web – How People Search – Search Interfaces Today–Visualization in Search Interfaces.

MODELING AND RETRIEVAL EVALUATION 9

Basic IR Models – Boolean Model – TF-IDF (Term Frequency/Inverse Document Frequency) Weighting – Vector Model – Probabilistic Model – Latent Semantic Indexing Model – Retrieval Evaluation – Retrieval Metrics – Precision and Recall – Reference Collection – User-based Evaluation – Relevance Feedback and Query Expansion – Explicit Relevance Feedback

TEXT CLASSIFICATION AND CLUSTERING 9

A Characterization of Text Classification – Unsupervised Algorithms: Clustering – Naïve Text Classification – Supervised Algorithms – Decision Tree – k-NN Classifier – SVM Classifier –Feature Selection or Dimensionality Reduction – Evaluation metrics – Accuracy and Error –Organizing the classes.

WEB RETRIEVAL AND WEB CRAWLING 9

The Web – Search Engine Architectures – Cluster based Architecture – Distributed Architectures – Search Engine Ranking – Link based Ranking – Simple Ranking Functions – Learning to Rank – Evaluations - Search Engine Ranking – Search Engine User Interaction – Browsing – Applications of a Web Crawler – Taxonomy – Architecture and Implementation – Scheduling Algorithms –Evaluation.

RECOMMENDER SYSTEM 9

Recommender Systems Functions – Data and Knowledge Sources – Recommendation Techniques – Basics of Content-based Recommender Systems – High Level Architecture – Advantages and Drawbacks of Content-based Filtering – Collaborative Filtering – Matrix factorization models – Neighborhood models.

d. Activities

Students shall be exposed to the core concepts of information retrieval and its associated algorithms using case study.

e. Learning Resources

Text Books

1. Ricardo Baeza-Yates and Berthier Ribeiro-Neto, *Modern Information Retrieval: The Concepts and Technology behind Search*, 2nd Edition, ACM Press Books, 2011.

2. Iresh A. Dhotre, *Information Retrieval Techniques*, Technical Publications, 2020.

3. Ricci F, Rokach, Shapira L and Kantor B, *Recommender Systems Handbook*, 1st Edition, 2011.

Reference Books

1. Manning C, Raghavan P and Schütze H, *Introduction to Information Retrieval*, Cambridge University Press, 2008.
2. Stefan Buettcher, Charles L A. Clarke and Gordon V. Cormack, *Information Retrieval: Implementing and Evaluating Search Engines*, The MIT Press, 2010.

Course Code	Course Name	L	T	P	C
VCS317	**DATA VISUALIZATION**	**2**	**0**	**2**	**3**

Category: Professional Elective Course (Theory cum Lab)

a. Preamble

This course focuses on the fundamental concepts of Data Visualization and Storytelling through the Tableau interface. This course enables the students to organize and present information intuitively and also exposed them to applying various visualization tools to develop real-time applications.

b. Course Outcome (Theory)

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Illustrate the fundamentals of Data visualization using the Tableau environment	K2
CO2	Demonstrate the various data transformation functions to customize the data	K2
CO3	Build meaningful Dashboards and Stories to explore the data	K3
CO4	Apply different chart and map forms to visualize and insight into the data	K3
CO5	Explain the need for Statistics tools to perform advanced data analysis	K2

Course Outcome (Lab)

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Build applications using various File types and Data connections in the Tableau environment	K3
CO2	Apply Data transformation techniques to simplify and slice the data	K3
CO3	Construct meaningful Dashboards and Stories for data exploration and visualization	K3
CO4	Choose different forms of the chart and map to visualize and insight into the data	K3
CO5	Identify the Statistics tools to perform advanced data analysis using Tableau	K3

c. Course Syllabus   **Total: 60 Periods**

FUNDAMENTALS OF VISUALIZATION AND TABLEAU   **6**

Introduction to Visualization – Top Data Visualization Tools – Reasons to make a switch to Tableau - File types in Tableau – Tableau environment - Connection to single and multiple data Sources.

SIMPLIFYING AND CUSTOMIZING DATA   **6**

Filtering – Sorting – Grouping – Number functions – String functions – Logical functions – Date functions – Aggregate functions – Table calculation functions.

DASHBOARD AND STORES   **6**

Creating a dashboard – Dashboard actions – Creating a story – Custom SQL - Integration of tableau with R.

CHARTS AND MAPS   **6**

Pie charts – Tree maps – Heatmap – Line graph – Gantt chart – Scatter plot – Histogram – Word cloud – Waterfall charts – Bump charts – Bullet graph.

STATISTICS TOOLS   **6**

Need for Statistics - Descriptive statistics – Inferential statistics – Number summary – Spread of data – Box plot – Statistics tools in Tableau – Reference lines – Trend lines – Forecasting.

1. Build an application by Connecting various single and multiple data sources using the default data source in Tableau "Sample-Superstore".

2. Apply various filtering, sorting, grouping, and logical functions to analyze the dataset of COVID cases worldwide and give real-time numbers for various regions.

3. Create Interactive Dashboard and Stories to analyze the dataset of different stocks and derive meaningful information.

4. Analyze a data set of marketing campaigns and visualize the performance of various marketing campaigns using different forms of the chart.

5. Analyze a dataset of various crimes happening at a place and visualize the data using maps and word clouds.

6. Build an application in tableau to predict and infer the risk to the patient's health.

7. Develop an application in tableau to detect anomalies and identify fraudulent transactions.

8. Construct a meaningful dashboard in tableau for Twitter sentiment analysis and integrate it with R Studio.

d. Activities

Students shall be exposed to applying various visualization techniques on the tableau and developing real-time applications.

e. Learning Resources

Text Book

1. Seema Acharya and Subashini Chellappan, *Pro Tableau*, Apress, 2017.

Reference Books

1. Claus O Wilke, *Fundamentals of Data Visualization*, 1st Edition, O'Reilly, 2019.

2. Arshad Khan, *Jumpstart Tableau*, Updated edition, Apress, 2016.

3. Ben Jones, *Communicating Data with Tableau*, 1st Edition, O'Reilly, 2014.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

S.No.	Description of Equipment	Quantity Required
1.	Personal Computers (Intel Core i3, 500GB, 4GB RAM)	30
2.	Printer	1
3.	Software: Tableau Public, R Studio	30

Course Code	Course Name	L	T	P	C
VCS321	**AGILE PROJECT DEVELOPMENT WITH SCRUM**	3	0	0	3

Category: Professional Elective Course

a. Preamble

This course enables the students to understand the concepts of agile methodology. This course enriches the skills of the students to iterative software development processes.

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Explain the fundamental concepts of agile software development methodology	K2
CO2	Demonstrate iterative software development processes using SCRUM	K2
CO3	Explain the processes and tools designed to address actual business needs	K2
CO4	Illustrate the techniques and tools for Requirements Engineering in Agile Practices	K2
CO5	Illustrate the advantages of Devops practices	K2

c. Course Syllabus   **Total : 45 Periods**

AGILE METHODOLOGY   **9**

Theories for Agile Management – Agile Software Development – Traditional Model vs Agile Model – Classification of Agile Methods – Agile Manifesto and Principles – Agility in Design - Testing – Agile Documentations – Agile Drivers, Capabilities and Values.

AGILE PROCESSES   **9**

Lean Production – SCRUM, Crystal, Feature Driven Development- Adaptive Software Development – Introducing GitLab – GitLab Flow – Merge Requests – Continuous Integration and Continuous Deployment – Extreme Programming: Method Overview – Lifecycle – Work Products, Roles and Practices.

AGILITY AND KNOWLEDGE MANAGEMENT 9

Agile Information Systems – Agile Decision Making – Institutional Knowledge Evolution Cycle – Development, Acquisition, Refinement, Distribution, Deployment, Leveraging – KM in Software Engineering – Managing Software Knowledge – Challenges of Migrating to Agile Methodologies – Agile Knowledge Sharing – Role of Story-Cards – Story-Card Maturity Model (SMM).

AGILITY AND REQUIREMENTS ENGINEERING 9

Overview of RE Using Agile – Requirements Elicitation – Agile Requirements Abstraction Model – Agile Requirements Modeling and Generation – Concurrency in Agile Requirements Generation.

DEVOPS 9

Devops: Motivation – Cloud as a platform – Operations – Deployment Pipeline – Overall Architecture – Building and Testing – Deployment – Case study: Migrating to Micro services – Version control systems: Git and Github.

d. Activities

Students shall be exposed to develop iterative software development process for real world application.

e. Learning Resources

Text Books

1. A.A.Puntambekar, *Agile Project Development with Scrum*, 1st Edition, Technical Publications, 2019.

2. Evertse, Joost, *Mastering GitLab 12*, Packt Publishing, 2019.

3. Len Bass, Ingo Weber and Liming Zhu, *DevOps: A Software Architect's Perspective*, Pearson Education, 2016.

Reference Books

1. David J. Anderson and Eli Schragenheim, *Agile Management for Software Engineering: Applying the Theory of Constraints for Business Results*, Prentice Hall, 2003.

2. Craig Larman, *Agile and Iterative Development: A Managers Guide*, Addison-Wesley, 2004.

3 Kevin C, Desouza, 2007, *Agile Information Systems: Conceptualization, Construction, and Management*, Butterworth Heinemann.

Course Code	Course Name	L	T	P	C
VCS322	**SOFTWARE TESTING AND QUALITY ASSURANCE**	3	0	0	3

Category: Professional Elective Course

a. Preamble

This course enables the students to understand the basic concepts about software testing processes. The students get familiarized with the test management and test automation techniques. This course focuses on various testing concepts and testing strategies.

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Explain the concepts of software testing and defect classes	K2
CO2	Outline the approaches of test case design suitable for testing the software	K2
CO3	Demonstrate the levels of testing for testing the Object Oriented system	K2
CO4	Illustrate test management strategies and organization structure of test team	K2
CO5	Apply selenium tool to test the Software	K3

c. Course Syllabus   **Total : 45 Periods**

INTRODUCTION   **9**

Testing as an Engineering Activity - Testing as a Process - Testing maturity model - Software Testing Principles-The Tester's Role in a Software Development Organization - Origins of Defects - Cost of Defects – Developer & Tester Support for Developing a Defect Repository.

TEST CASE DESIGN   **9**

Test case Design Strategies - Using Black Box Approach to Test Case Design - Boundary Value Analysis - Equivalence class Partitioning - State Based Testing, Cause-effect graphing - Using White - Box Approach to Test design - Test Adequacy Criteria - Coverage and Control Flow Graphs - Covering Code Logic - Code Complexity Testing.

LEVELS OF TESTING   **9**

The Need for Levels of Testing - Unit Test Planning - Designing the Unit Tests - Integration Tests - Designing Integration Tests - Integration Test Planning - System Testing - Acceptance Testing - Performance Testing - Regression Testing - Compatibility Testing, Testing the Documentation - Website Testing.

TEST MANAGEMENT   **9**

People and Organizational Issues in Testing - Organization Structures for testing teams - Testing Services - Test Management - Test Process - Reporting Test Results - Building a Testing Group - Structure of Testing Group - Google Extension - The technical training program.

SELENIUM   **9**

Introduction – Selenium IDE, RC - Selenium WebDriver -Selenium Components - Selenium IDE – TestNG- Maven - UI elements Locators – Xpath - CssSelector - TestNG Annotations and Data Providers – Jenkins – Modular Framework – Paramitarization- Hybrid Framework.

d. Activities

Students shall be exposed to the concepts of software testing using case study.

e. Learning Resources

   Text Books

   1. Paul C, Jorgensen, *Software Testing: A Craftsman's Approach*, 5th Edition, Auerbach Publications, 2022.

   2. Yogesh Singh, *Software Testing*, Cambridge University Press, 2012.

   Reference Books

   1. Glenford J. Myers, Corey Sandler, Tom Badgett, *The Art of Software Testing*, 3rd Edition, John Wiley & Sons, Inc, 2012.

   2. Satya Avasarala, *Selenium WebDriver Practical Guide*, Packt Publishing, 2014.

Course Code	Course Name	L	T	P	C
VCS323	**REST FRAMEWORK FOR BUSINESS APPLICATIONS**	**2**	**0**	**2**	**3**

Category: Professional Elective Course (Theory cum Lab)

a. Preamble

This course enables the students to develop web based applications using DJANGO framework. This course enriches the web development skills of the students to fulfill the end user's requirement.

b. Course Outcome (Theory)

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Explain the concept of views and templates	K2
CO2	Develop web applications using models and databases	K3
CO3	Build web applications using Forms and Query processing	K3
CO4	Apply User Authentication concepts in web applications	K3
CO5	Explain various State Management techniques in Django	K2

Course Outcome (Lab)

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Develop simple Django application using HTML	K3
CO2	Build simple Django application using models	K3
CO3	Develop Django application using forms	K3
CO4	Build Django application for secured data access	K3
CO5	Construct a Django customized web site for a specific customer	K3

c. Course Syllabus   **Total : 60 Periods**

INTRODUCTION TO DJANGO   6

Installing DJANGO - setting up environment - DJANGO Architecture - Basics DJANGO CLI - Starting a Project and Application - Views - Http Responses - URLs – Templates – Introduction to Flask.

MODELS   6

Setting Up a Database - Django Models - Querying with models - Working with templates - Django Administration Site.

FORMS   6

Working with Forms - Custom Validation Rules - Working with Filters - Query Fetching - JSON - Working with JSON - Generic Views – Mail.

AUTHENTICATION   6

Users and Authentication - Enabling Authentication Support - Logging in and out - Managing Users, Permissions and Groups - Using Authentication Data in Templates.

STATE MANAGEMENT   6

Cookies - Getting and Setting Cookies - Django's Session Framework - Using Sessions in Views - Using Sessions Outside of Views - Other Session Settings – Caching – Types of caching.

LIST OF LABORATORY EXPERIMENTS   30

1. Build a Personal Portfolio Webpage
2. Develop a home page for a general store to display their aim, features, products and contact information
3. Develop a user authentication page for library application
4. Develop a Feedback form for a technical event conducted in an engineering college with validation
5. Develop a Dynamic web site for a college to represent departments features and activities
6. Implement a user registration form and store the data in DB
7. Develop an enquiry form and send the responses through mail
8. Write a Django application to restrict the page access to certain users

d. Activities

Students shall be exposed to DJANGO framework concepts and to develop simple web applications to demonstrate the different concepts

e. Learning Resources

Text Books

1. Nigel George, *Build a Website With Django 3: A complete introduction to Django*, GNW Independent Publishing, 2019.
2. Adrian Holovaty, Jacob K. Moss, *The Definitive Guide to Django: Web Development Done Right*, 2nd Edition, Apress, 2009.

Reference Books

1. Antonio mele, *Django 3 By Example: Build powerful and reliable Python web applications from scratch*, 3rd Edition, Packt Publication, 2020.
2. William S. Vincent, *Django for Beginners*, Lean Publishing, 2020.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

S. No.	Description of Equipment	Quantity Required
1.	Personal Computers (Intel Core i3, 500GB, 4 GB RAM)	30
2.	Printer	1
3.	Software: Visual Studio Code, Python, SQLite	30

Course Code	Course Name	L	T	P	C
VCS324	**FULL STACK DEVELOPMENT**	**2**	**0**	**2**	**3**

Category: Professional Elective Course (Theory cum Lab)

a. Preamble

This course enables the students to develop both front-end and back-end of a web application. This course enriches the logical skills of the students on the latest web technologies, tools and libraries.

b. Course Outcome (Theory)

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Illustrate responsive web pages using Bootstrap and jQuery	K2
CO2	Explain an Angular.JS for web application development	K2
CO3	Demonstrate the simple web applications using node	K2
CO4	Infer web applications using express and node	K2
CO5	Outline the concepts of MongoDB with CURD operations	K2

Course Outcome (Lab)

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Build responsive web design using Bootstrap and jQuery	K3
CO2	Develop simple web applications using Angular framework	K3
CO3	Build web applications using Node.js Framework	K3
CO4	Construct web applications using Express.js Framework	K3
CO5	Develop web applications using MongoDB	K3

c. Course Syllabus **Total : 60 Periods**

INTRODUCTION TO FULLSTACK DEVELOPMENT **6**

Overview of Fullstack development – MEAN stack framework - Introduction to Bootstrap– Layouts – Components – Forms – Introduction to JQuery.

ANGULAR FRAMEWORK **6**

Introduction to Angular - Binding and Expression – Directives – Controllers – Filters – Modules – Services – Scopes – Tables & forms – Angular DOM – Routing.

NODE.JS FRAMEWORK   6

Introduction to Node.js – Node.js Architecture – NPM (Node Packaging Manager) - Installing NPM module - Creating and locating modules - Creating a simple HTTP server.

EXPRESS.JS FRAMEWORK   6

Overview of Express.js framework – Simple Express application – Routing – MVC in Express – Middleware – Templates – Error handling – API and Socket call.

MONGODB   6

Overview of NoSQL– Introduction to MongoDB - Basic CRUD Operations – Indexing – Aggregation -Data Modeling concepts - Connecting MongoDB using Mongoose.

LIST OF LABORATORY EXPERIMENTS   30

1. Develop a single page Company web site using Bootstrap
2. Develop Quiz web application using jQuery
3. Develop To-Do-List application using AngularJS
4. Develop a BMI application using Node.JS framework
5. Build Employee Survey application to demonstrate GET/POST Request method in Express JS
6. Build Student Management application to perform CRUD operations using Express.JS and MongoDB

d. Activities

Students shall be exposed to Frond-end Technologies and Back-end Technologies concepts to solve real-time problems.

e. Learning Resources

Text Books

1. Vasan Subramanian, *Pro MERN Stack, Full Stack Web App Development with Mongo, Express, React, and Node*, Apress Publisher, 2019.
2. Brad Dayley and Brendan Dayley, *Node.js, MongoDB and Angular Web Development*, 2nd Edition, Pearson Education, 2018.

Reference Books

1. Cay S Chris Northwood, *The Full Stack Developer: Your Essential Guide to the Everyday Skills Expected of a Modern Full Stack Web Developer*, Apress Publisher, 2018.
2. Adam Bretz and Colin J Ihrig, *Full Stack JavaScript Development With MEAN*, Sitepoint Publisher, 2015.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

S. No.	Description of Equipment	Quantity Required
1.	Personal Computers (Intel Core i3, 250GB, 4 GB RAM)	30
2.	Printer	1
3.	Software: Visual Studio Code, Node.js, MongoDB, Angular.js	30

Course Code	Course Name	L	T	P	C
VCS325	**APPLICATION DEVELOPMENT USING FLUTTER**	**2**	**0**	**2**	**3**

Category: Professional Elective Course (Theory cum Lab)

a. Preamble

This course enables the students to develop a mobile application for real world challenges.

This course gives a hands-on experience on cross platform framework Flutter.

b. Course Outcome (Theory)

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Explain the features and installation process of Flutter	K2
CO2	Explain the basics of Dart and the common widgets	K2
CO3	Develop simple Flutter application using Layouts	K3
CO4	Build Animation on Flutter	K3
CO5	Construct database application using Firebase	K3

Course Outcome (Lab)

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Develop simple Flutter application using widgets	K3
CO2	Build simple Flutter application using Intents and Layouts	K3
CO3	Develop Flutter application using Custom widgets	K3
CO4	Build Flutter application for text to speech conversion	K3
CO5	Construct database application using Firebase	K3

c. Course Syllabus   **Total : 60 Periods**

INTRODUCTION TO FLUTTER   **6**

Introduction - Advantages of Flutter- Disadvantages of Flutter - Flutter Installation- Creating Hello World App - Architecture of Flutter Applications.

WIDGETS   6

Dart Basics –Widgets – Widget Tree - Common Widgets - Widget Build Visualization.

LAYOUTS   6

Layout – Weather Section Layout -Tags Layout – Footer Images Layout – Final Layout.

ANIMATION   6

Animated Container - App's Navigation – Scrolling Lists and Effects – List View – Grid View, Making the UI responsive for web, Android and iOS.

DATABASE CONNECTIVITY USING FIREBASE   6

JSON Format - Building the Journal App - Firebase and Firestore Backend - Cloud Fire store - Firestore client App.

LIST OF LABORATORY EXPERIMENTS   30

1. Develop a mobile application for implementing a counter using floating action button
2. Develop a mobile application for library management using widgets
3. Develop a mobile application for implementing login credentials with appropriate Toast messages
4. Develop a mobile application using alertbox
5. Develop a mobile application for implementing Banking transactions using intents and layouts
6. Develop a mobile application using Custom widgets in Flutter: App Bar, Drawer, Bottom Navigation Bar
7. Develop a mobile application for text to speech conversion
8. Develop a mobile application using Flutter Firebase

d. Activities

Students shall be exposed to Dart programming concepts and to design applications for solving simple problems using Flutter.

e. Learning Resources

Text Book

1. Macro L.Napoli, *Beginning Flutter- A Hands on Guide To App Development*, John Wiley & Sons Inc, 2020.

Reference Book

1. Rap Payne, *Beginning App Development with Flutter: Create Cross-Platform Mobile Apps (English Edition),* 1st Edition, Apress, 2019.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

S. No.	Description of Equipment	Quantity Required
1.	Personal Computers (Intel Core i3, 500GB, 8 GB RAM)	30
2.	Printer	1
3.	Software: Android Studio	30

Course Code	Course Name	L	T	P	C
VCS326	UI UX DESIGN	2	0	2	3

Category: Professional Elective Course (Theory cum Lab)

a. Preamble

This course enables the students to understand the theories, principles and practice of user interface design and user experience design. This course helps the students to present the information effectively to the potential users. This course enriches the logical skills of the students to design the user interface for real time applications.

b. Course Outcome (Theory)

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Explain the basic user interface and user experience design concepts	K2
CO2	Illustrate user experience design process and its methodology	K2
CO3	Develop user interface design for real time applications	K3
CO4	Build simple application design using design tools	K3
CO5	Explain reusable user interface design using design pattern	K2

Course Outcome (Lab)

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Develop Artboards for real time applications	K3
CO2	Experiment with user experience design process	K3
CO3	Construct graphics for user interface design	K3
CO4	Apply tools and designs for user interface and experience	K3
CO5	Build Responsive user interface design for real time applications	K3

c. Course Syllabus   **Total: 60 Periods**

INTRODUCTION   6

Introduction to User Interface (UI) and User Experience (UX) – Evolution of Design – Need of Good design – UX design to UI design –Principles of UI and UX Design – Core Stages of Design Thinking – Characteristics of graphical and web user interfaces.

USER EXPERIENCE DESIGN PROCESS   6

UX Design Process and its Methodology – Requirement Gathering – User Research – Analysis – Design phase – Usability Testing – Information architecture – Sitemaps.

DESIGNING USER INTERFACES   6

Designing for People – Spacing and Grid – Responsive Grids and Breakpoints – Typography– Color Schemes – Visual Assets – Plugins and Icons – Accessibility – Getting Input from Users – Forms and Controls

WIREFRAMING AND PROTOTYPING   6

Tools used for UI and UX Design – Wireframing – Principles of wireframing – Build Prototypes – Create interaction – Share Prototypes – Comment on Prototype – Incorporate feedback – Export designs.

DESIGN EXPLORATION   6

Design Patterns – Analyzing Design Patterns – Mobile Design – Visual Style – Design Fidelity – Micro Interactions – Components – Cards – Layout and composition – Using Templates.

LIST OF LABORATORY EXPERIMENTS   30

1. Construct and manage Artboards for an e-commerce application
2. Identify the users for an agriculture information system by conducting end-to-end user research methods
3. Develop an interface for responsive home page of hotel management system using Icons, Primary and Secondary Buttons
4. Develop an interface using Plugins, color and accessibility for an integrated transport system in a metro city
5. Implementation of wireframing, prototyping, sharing and exporting the project for the online food ordering application
6. Develop a responsive layout using templates for a societal application

d. Activities

Students shall be exposed to UI and UX Design concepts and to make simple design using User Interface Design tools.

e. Learning Resources

Text Books

1. Jenifer Tidwell, Charles Brewer, Aynne Valencia, *Designing Interfaces,* 3rd Edition, O'Reilly Media, 2020.
2. Joel Marsh, *UX for Beginners*, O'Reilly, 2022.

Reference Books

1. David Platt, *The Joy of UX: User Experience and Interactive Design for Developers*, Addison-Wesley Professional, 2016.
2. Elisa Paduraru, *Fundamentals of Creating a Great UI/UX,* Creative Tim, 2022.
3. Peter Morville, Louis Rosenfeld, *Information Architecture for the World Wide Web,* 3rd Edition, O'Reilly Media, 2015.
4. Garrett JJ, The elements of user experience: user-centered design for the Web, Berkeley: New Riders, 2011.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

S. No.	Description of Equipment	Quantity Required
1.	Personal Computers (Intel Core i3, 250GB, 8 GB RAM)	30
2.	Printer	1
3.	Software: Figma	30

Course Code	Course Name	L	T	P	C
VCS327	**C# AND .NET FUNDAMENTALS**	**2**	**0**	**2**	**3**

Category: Professional Elective Course (Theory cum Lab)

a. Preamble

This course enables the students to learn object oriented and advanced features of C# programming for solving simple problems. This course also focuses on developing simple database application and web application using ASP.NET.

b. Course Outcome (Theory)

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Explain the .NET architecture and C# language fundamental constructs	K2
CO2	Develop simple applications in C# using object oriented programming concepts.	K3
CO3	Illustrate the use of delegates, exception handling and multithreading in C#	K2
CO4	Explain the basic features of ASP.NET and its controls	K2
CO5	Build database driven ASP.NET applications and web services	K3

Course Outcome (Lab)

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Build a simple C# application using jagged array	K3
CO2	Develop simple C# programs using different types of function parameters	K3
CO3	Build object oriented programs using C# class and constructors	K3
CO4	Develop simple applications in C# using exception handling and delegate concepts	K3
CO5	Construct three tier applications using ASP.NET	K3

c. Course Syllabus   **Total : 60 Periods**

INTRODUCTION TO .NET AND C# FUNDAMENTALS   6

Introduction to .NET Architecture - CLS, CTS, BCL, Overview of C# - Data types, Literals and Variables, Boxing and Un Boxing - Operators - Control statements - Parameter passing mechanisms - Arrays, Strings.

OBJECT ORIENTED CONCEPTS IN C#   6

Classes and Objects, Inheritance: Virtual methods and Overriding - Abstract Class, Sealed Class - Interfaces - Generic classes and methods – Collection.

ADVANCED FEATURES OF C#   6

Exception handling - Delegates and Events - lambda expressions, Multithreading - Properties– Reflection.

WEB APPLICATIONS   6

Introduction to ASP.NET - ASP.NET web application - Web forms - Code behind model - Autopostback - Validating controls - Master and Content pages.

ASP.NET AND DATABASE CONNECTIVITY   6

Data provider classes - Connection - Command - Data Reader - Data Adapter - Data Controls- Grid View - FormView – DetailsView - Concept of state - Web services.

LIST OF LABORATORY EXPERIMENTS   30

1) Implement a C# program to find the sum of each row of a jagged array
2) a) Develop a C# program to swap two numbers using ref parameter

    b) Develop a C# program to find the area of triangle using in and out parameters
3) a) Create a C# class named Circle constructed by a data member "radius" and two methods which will compute the area and the perimeter of a circle

    b) Define a STUDENT class with roll number, name and marks in 3 tests of subjects. Use appropriate functions to find the average of two best marks for a student and print the roll number, name and average marks of a student. First, initialize the data members using constructors
4) Create a class *Time* to display a time value with the data members of hours, minutes and seconds. Include the member functions to get and display the time separated by: (HH:MM:SS). Assume the time is represented in 12 hours. If the input value exceeds the hour, minute and second then your function should report the

exception as invalid hour/minute/second. Write a C# program to model the above relationships

5) Write a program to create a delegate called TrafficDel and a class called TrafficSignal with the following delegate methods

```
Public static void Yellow()
{
Console.WriteLine("Yellow Light Signal To Get Ready");
}
Public static void Green()
{
Console.WriteLine("Green Light Signal To Go");
}
Public static void Red()
{
Console.WriteLine("Red Light Signal To Stop");
}
```

Also include a method IdentifySignal() to initialize an array of delegate with the above methods and a method show() to invoke members of the above array

6) The department table consists of two fields (DeptID, DeptName). Write an ASP.NET web application to insert, update, delete and display the records in the department table

d. Activities

Students shall be practiced to solve the simple real time use case and to debug the C# code effectively.

e. Learning Resources

Text Books

1. Herbert Schildt, *C# 4.0: The Complete Reference*, Reprint, McGraw Hill Education, Indian Edition, 2017.

2. Andrew Troelsen, Philip Japikse, *Pro C# 10 with .NET: Foundational Principles and Practices in Programming*, 11th Edition, Apress, 2022.

Reference Books

1. Mark Michaelis, Eric Lippert, *Essential C# 6.0*, Pearson, 2015.

2. John Sharp, *Microsoft Visual C# 2013 Step by Step Developer*, Pearson Education, 2013.

3. Thamarai Selvi, S, Murugesan, R, *A textbook on C#*, Pearson, 2012.

4. Joseph Albahari, Ben Albahari, *C# 4.0 in a Nutshell: The Definitive Reference*, O'Reilly, 2010.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

S. No.	Description of Equipment	Quantity Required
1.	Personal Computers (Intel Core i3, 500GB, 4 GB RAM)	30
2.	Printer	1
3.	Software: Microsoft Visual Studio, SQL Server or equivalent	30

Course Code	Course Name	L	T	P	C
VCS331	**ETHICAL HACKING**	3	0	0	3

Category: Professional Elective Course

a. Preamble

This course enables the students to understand the security vulnerabilities and threats and the process of Ethical Hacking. This course focuses on the techniques used for system hacking and web services hacking. Students get the exposure of security management tools to identify unauthorized access or malicious activities.

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Explain the fundamentals of Ethical Hacking	K2
CO2	Outline the process of Scanning and Enumeration with prominent tools	K2
CO3	Explain the system hacking techniques to identify the security vulnerabilities	K2
CO4	Summarize real-world hacking techniques in web applications	K2
CO5	Demonstrate the use of Security Management Tools	K2

c. Course Syllabus   **Total : 45 Periods**

INTRODUCTION   **9**

Introduction to Hacking – Importance of Security – Elements of Security – Phases of an Attack – Types of Hacker Attacks – Hacktivism – Vulnerability Research – Introduction to Footprinting – Information Gathering Methodology – Footprinting Tools – WHOIS Tools – DNS Information Tools – Locating the Network Range – Meta Search Engines.

SCANNING AND ENUMERATION   **9**

Introduction to Scanning – Objectives – Scanning Methodology – Tools – Introduction to Enumeration – Enumeration Techniques – Enumeration Procedure – Tools.

SYSTEM HACKING   **9**

Introduction – Cracking Passwords – Password Cracking Websites – Password Guessing – Password Cracking Tools – Password Cracking Counter measures – Escalating Privileges – Executing Applications – Keyloggers and Spyware.

ETHICAL HACKING IN WEB **9**

Social Engineering - Session Hijacking - Hacking Web servers - Hacking Web Applications - SQL Injection - Hacking Wireless Networks - Hacking Mobile Platforms.

SECURITY MANAGEMENT TOOLS **9**

Management of security assessments with Metasploit – Honeypots – Intrusion Detection System – SolarWinds - Security Event Manager (SEM) Sagan – Kismet.

d. Activities

Students shall be exposed to the core concepts of Ethical Hacking and its tools using case study.

e. Learning Resources

Text Books

1. EC-Council, *Ethical Hacking and Countermeasures: Attack Phases,* 2nd Edition, Cengage Learning, Nelson Education, 2016.

2. Shimonski, R, *CEH v9: Certified Ethical Hacker Version 9 Study Guide,* John Wiley & Sons, 2016.

Reference Books

1. Michael T Simpson, *Hands-on Ethical Hacking & Network Defense*, Course Technology, 2010.

2. Thomas Mathew, *Ethical Hacking*, OSB publishers, 2003.

3. Ramachandran V, Back Track, *Wireless Penetration Testing Beginner's Guide*, 3rd Edition, Packt Publishing, 2011.

Course Code	Course Name	L	T	P	C
VCS332	**PRINCIPLES OF CYBER SECURITY**	3	0	0	3

Category: Professional Elective Course

a. Preamble

This course enables the students to understand how an organization should implement cyber security designed for protecting their systems and data from cyber threats. Students get to know the measures and techniques required to protect OS and Network from security threats and intrusions. This course focuses on the security countermeasures and cyber law in force which prosecute unlawful cyber practices.

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Explain the fundamentals of cyber security	K2
CO2	Discuss the various security aspects in OS and networks	K2
CO3	Summarize various security measures to safeguard resources	K2
CO4	Outline the privacy aspects in cyber space	K2
CO5	Explain the security planning and cyber laws in force	K2

c. Course Syllabus   **Total : 45 Periods**

INTRODUCTION TO CYBER SECURITY   **9**

Introduction - Computer Security - Threats -Harm - Vulnerabilities - Controls - Authenticate Access Control and Cryptography - Web User Side - Browser Attacks - Web Attack Targeting Users - Obtaining User or Website Data - Email Attacks.

SECURITY IN OPERATING SYSTEM & NETWORKS   **9**

Security in the Design of Operating Systems - Rootkit - Network security attack - Threats to Network Communications - Wireless Network Security - Denial of Service - Distributed Denial-of-Service.

SECURITY COUNTERMEASURES 9

Cryptography in Network Security - Firewalls - Intrusion Detection and Prevention Systems - Network Management - Databases - Security Requirements of Databases - Reliability and Integrity - SQL Injection Attacks –Data breaches - Case studies.

PRIVACY IN CYBERSPACE 9

Privacy Concepts - Privacy Principles and Policies - Authentication and Privacy - Data Mining - Privacy in the Web - Email Security - Privacy Impacts of Emerging Technologies –Fields of Cybersecurity.

SECURITY MANAGEMENT AND INCIDENTS 9

Security Planning - Business Continuity Planning - Handling Incidents - Risk Analysis - Dealing with Disaster - Emerging Technologies - The Internet of Things - Economics - Electronic Voting - Cyber Warfare - Cyberspace and the Law - International Laws – Cybercrime - Cyber Warfare and Home Land Security.

d. Activities

Students shall be exposed to the core concepts of cyber security using case study.

e. Learning Resources

   Text Books

   1. Charles P Pfleeger, Shari Lawrence Pfleeger and Jonathan Margulies, *Security in Computing*, 5th Edition, Pearson Education, 2018.
   2. George K Kostopoulous, *Cyber Space and Cyber Security*, 2nd Edition, CRC Press, 2017.

   Reference Books

   1. Martti Lehto and Pekka Neittaanmäki, *Cyber Security: Analytics, Technology and Automation edited,* Springer International Publishing Switzerland, 2015.
   2. Nelson Philips and Enfinger Steuart, *Computer Forensics and Investigations*, 6th Edition, Cengage Learning, New Delhi, 2020.

Course Code	Course Name	L	T	P	C
VCS333	**DevOps for Cloud**	**2**	**0**	**2**	**3**

Category: Professional Elective Course (Theory cum Lab)

a. Preamble

This course enables the students to understand the importance of DevOps and its tools. This course enriches the students to be aware of different Version control tools. This course enables the students to get familiarized with DevOps environment.

b. Course Outcome (Theory)

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Explain the importance of DevOps tools used in cloud	K2
CO2	Demonstrate the concepts of Jenkins to Build, Deploy and Test Software Applications	K2
CO3	Explain about the different Container strategies in Docker	K2
CO4	Explain about the Kubernetes concepts	K2
CO5	Summarize the importance of Ansible tools	K2

Course Outcome (Lab)

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Identify the basic concepts of Jenkins	K3
CO2	Apply the performance using different version control tools	K3
CO3	Build applications using Docker	K3
CO4	Construct microservices in Kubernetes	K3
CO5	Experiment the installation of Ansible	K3

c. Course Syllabus   **Total:60 periods**

DEVOPS IN CLOUD   **6**

Essentials of Cloud Computing – Cloud and Virtualization Architecture – Cloud Deployment Architecture – Need of DevOps on Cloud – Introduction to AWS – DevOps Principles – DevOps Delivery Pipeline – Market Trends – Technical Challenges – Tools used in DevOps.

JENKINS AND GIT INTEGRATION   **6**

Version Control – Essentials of GIT – How to setup GIT – GIT Workflows – Jenkins Architecture – Essentials of Continuous Integration – Jenkins Tool Management – User management in Jenkins – Notification Settings in Jenkins – Terraform Architecture – Terraform CLI.

DOCKER DEPLOYMENT   **6**

Introduction to Docker – Docker Tools – Docker Swarm – Docker Networking –Working with Container – Docker deployment and orchestration.

KUBERNETES CONTAINER ORCHESTRATION   **6**

Introduction to Kubernetes – Kubernetes Cluster Architecture –Understanding Labels, Selectors, Jobs, and Schedulers.

ANSIBLE AUTOMATION PLATFORM   **6**

Introduction– Ansible Modules – How to use Adhoc Commands – Introduction to YAML Script Playbook.

LIST OF LABORATORY EXPERIMENTS   **30**

1. Deployment of Web applications using Jenkins
2. Performance of Version Control on websites using different Version control tools like GIT
3. Installation and Configuration Docker for creating Containers of different Operating System Images
4. Build, deploy and manage web or Java application on Docker.
5. Deployment of micro services in Kubernetes.
6. Installation and configuration of Software Configuration Management and provisioning using Ansible.

d. Activities

Students shall be exposed to DevOps tools like Jenkins, Kubernetes and Ansible for deploying in web applications.

e. Learning Resources

Text Books

1. Karl Matthias and Sean P. Kane, *Docker: Up and Running*, 2nd Edition, O'Reilly Publication, 2018.

2. Len Bass, Ingo Weber, Liming Zhu, *DevOps, A Software Architects Perspective*, 1st Edition, Addison–Wesley–Pearson Publication, 2015.

3. John Ferguson Smart, *Jenkins The Definitive Guide*, O'Reilly Publication, 2011.

Reference Books

1. Sanjeev Sharma and Bernie Coyne, *DevOps for Dummies*, 2nd Edition, Wiley Publication, 2015.

2. Httermann, Michael, *DevOps for Developers*, Apress Publication, 2012.

3. Joakim Verona, *Practical DevOps*, 2nd Edition, Pack publication, 2018.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

S.No.	Description of Equipment	Quantity Required
1.	Personal Computers (Intel Core i3, 500GB, 4 GB RAM)	30
2.	Printer	1
3.	Software: JDK, NetBeans IDE or equivalent	30

Course Code	Course Name	L	T	P	C
VCS334	**BLOCKCHAIN TECHNOLOGIES**	2	0	2	3

Category: Professional Core Course (Theory cum Lab)

a. Preamble

This course helps the students to understand the Blockchain structure and the consensus mechanisms. This course enriches the students to develop a smart contract using solidity programming. This course enables the students to develop a Ethereum DApp to deploy a smart contract for real time application.

b. Course Outcome (Theory)

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Interpret the Components, types and Application of Blockchain Technology.	K2
CO2	Explain the algorithms that supports Distributed Consensus	K2
CO3	Construct a Ethereum network using Ethereum Virtual Machine	K3
CO4	Apply solidity programming for deploying a smart contract for a real-time application.	K3
CO5	Build a Ethereum DApp for a real time application using blockchain	K3

Course Outcome (Lab)

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Build a Merkle Tree in blockchain	K3
CO2	Construct a block in Blockchain	K3
CO3	Develop a smart contract for interacting with the transactions using Remix IDE	K3
CO4	Construct a blockchain and to implement transactions	K3
CO5	Model a Private Network using Ethereum Virtual Machine to perform mining	K3

c. Course Syllabus   **Total: 60 Periods**

INTRODUCTION TO BLOCKCHAIN   **6**

Introduction – Components of Blockchain – Blockchain Architecture –-Structure of Blockchain – Types of Blockchain – Tiers of Blockchain technology – Cryptocurrencies – Cryptographic primitives – Hash functions – Applications of Blockchain.

CONSENSUS MECHANISMS AND SMART CONTRACTS   **6**

Introduction – Distributed Consensus – Paxos – RAFT Consensus – Byzantine Fault Tolerant (BFT) System – Pease BFT algorithm – Practical Byzantine Fault Tolerance (PBFT) System. – Smart contracts – Need of Smart Contract in real world applications.

ETHEREUM SMART CONTRACT   **6**

Ethereum overview – Ethereum network – Components of Ethereum – The Ethereum Virtual Machine (EVM) – Smart Contracts – Mining on the private network – using MetaMask and Remix IDE to deploy smart contract.

SOLIDITY PROGRAMMING   **6**

The solidity Compiler – Tools and Libraries – Smart Contract development and Deployment – Layout of Solidity source code – solidity language – variables – Datatypes – Control Structures – Events- Inheritance- Libraries – Functions – Error handling.

BUILDING ETHEREUM DAPP   **6**

Dapp – Metamask – Setting up a Private Ethereum Network – Install go-etherum – Create geth Data directory – Create a geth account – create genesis.json configuration File – Run the first Node of the Private Network – Run the second node of the Network – Creating Smart Contract – Deploying the Smart Contract – Client Application.

LIST OF LABORATORY EXPERIMENTS   **30**

1.   Creation of Merkle Tree for data verification and synchronization in blockchain.
2.   Creation of a block in blockchain.
3.   Deposit some Ether in your MetaMask accounts.
4.   Create several accounts using MetaMask and make some transactions between these accounts.
5.   Develop a Smart Contract using Solidity programming and interacting with the smart contract using Remix IDE.
6.   Creating and adding transactions to a blockchain using Ethereum.

7. Interacting with the blockchain using Geth console.

8. Mining on a private network to view transactions and blocks using Ganache.

d. Activities

Students shall be exposed to the developing real-time applications using blockchain technology.

e. Learning Resources

Text Books

1. Imran Bashir, *Mastering Blockchain: A deep dive into distributed ledgers, consensus protocols, smart contracts, Dapps, Cryptocurrencies, Ethereum, and more*, 3rd Edition, Packt Publishing, 2020.

2. Ritesh Modi, *Solidity Programming Essentials: A beginner's guide to build smart contracts for Ethereum and blockchain,* Packt Publishing, 2018.

Reference Books

1. Kevin Solorio, Randall Kanna, David H. Hoover, *Hands-On Smart Contract Development with Solidity and Ethereum*, 1st Edition, O'Reilly Media, 2019.

2. Andreas Antonopoulos, Gavin Wood, *Mastering Ethereum*, 1st Edition, O'Reilly Media, 2018.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

S. No.	Description of Equipment	Quantity Required
1.	Personal Computers (Intel Core i3, 500GB, 4 GB RAM)	30
2.	Printer	1
3.	Software: Python, Remix IDE, MetaMask, Geth, Ganache, Ethereum Virtual Machine, solc compiler	30

Course Code	Course Name	L	T	P	C
VCS335	**VIRTUALIZATION AND CLOUD COMPUTING**	2	0	2	3

Category: Professional Elective Course (Theory cum Lab)

a. Preamble

This course enables the students to understand the importance of the cloud concepts. This course enriches the knowledge on the various securities in cloud computing. This course focuses on the emergence of cloud as the next generation computing paradigm.

b. Course Outcome (Theory)

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Explain the basic concepts of cloud computing and its principles	K2
CO2	Apply virtualization techniques for efficient resource utilization	K3
CO3	Summarize various models, services and resource management in cloud computing	K2
CO4	Apply cloud services in different programming models and software environment	K3
CO5	Interpret security and resource allocation issues in cloud computing	K2

Course Outcome (Lab)

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Experiment with various virtualization tools such as Virtual Box, VMware workstation.	K3
CO2	Develop web applications in a PaaS environment.	K3
CO3	Model a cloud environment to implement new schedulers.	K3
CO4	Show the Installation and use a generic cloud environment that can be used as a private cloud.	K3
CO5	Apply large data sets in a parallel environment.	K3

c. Course Syllabus   Total : 60 Periods

INTRODUCTION, PRINCIPLES AND ARCHITECTURE   6

Cloud Computing: Reference model – Characteristics and challenges – Historical development building cloud computing environment – Technologies for distributed computing – Cloud Computing Architecture: NIST Cloud Computing Reference Architecture – Types of Clouds – Cloud Service Providers.

VIRTUALIZATION TECHNOLOGIES   6

Characteristics of virtualized environments – Taxonomy of virtualization techniques –Execution virtualization – Hypervisors Hardware virtualization techniques – Operating system Level virtualization – Application Level virtualization – Virtualization and cloud computing – Pros and cons of virtualization.

CLOUD INFRASTRUCTURE AND RESOURCE MANAGEMENT   6

Cloud Computing and Services Model – Public, Private and Hybrid Clouds – Cloud Eco System IaaS – PaaS – SaaS – Architectural Design of Compute and Storage Clouds – Layered Cloud Architecture Development – Cloud Costing - Design Challenges – Inter Cloud Resource Management.

CLOUD DEVELOPMENT ENVIRONMENT   6

Cloud capabilities and platform features – Hadoop – HDFS – MapReduce – Mapping Applications – Cloud Platforms – Cloud Service Providers - Amazon Web Service – Microsoft Azure - Google App Engine- Open Stack.

CLOUD SECURITY   6

Cloud Computing Risk Issues – Cloud Computing Security Challenges – Cloud Computing Security Architecture – Trusted cloud Computing – Identity Access Management and Control.

LIST OF LABORATORY EXPERIMENTS   30

1. Configure a VM instance in your local machine and in cloud - Allocate CPU, memory and storage space as per a specified requirement and Install Guest OS image in that instance.

2. Configure a Nested Virtual Machine (VM under another VM) in cloud and local machine. Install OS images and work with OS commands.

3. Find a procedure to transfer the files from one virtual machine to another virtual machine.

4. Deploying a Sample Python Application on Google Cloud Platform App Engine.

5. Demonstrate cloud application using Windows Azure.

6. Implementation of Amazon cloud services - EC2, S3

7. Simulate a cloud scenario using CloudSim and run a scheduling algorithm that is not present in CloudSim.

8. Install the Hadoop framework and create an application using Map Reduce Programming Model.

9. Creating and Executing Your First Container Using Docker.

d. Activities

Students shall be exposed to cloud computing and to implement the cloud concepts

e. Learning Resources

Text Books

1. Rittinghouse, John W and James F. Ransome, *Cloud Computing: Implementation, Management and Security*, CRC Press, 2017.

2. Kai Hwang, Geoffery C Fox and Jack Dongarra, *Distributed and Cloud Computing: Clusters, Grids, Clouds and the Future of Internet*, 1st Edition, Morgan Kaufman Publisher, an Imprint of Elsevier, 2012.

Reference Books

1. Rajkumar Buyya, Christian Vecchiola and ThamaraiSelvi S, *Mastering Cloud Computing*, Tata Mcgraw Hill, 2013.

2. Toby Velte, Anthony Velte and Robert Elsenpeter, *Cloud Computing – A Practical Approach*, Tata Mcgraw Hill, 2009.

3. George Reese, *Cloud Application Architectures: Building Applications and Infrastructure in the Cloud: Transactional Systems for EC2 and Beyond (Theory in Practice)*, O'Reilly, 2009.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

S.No.	Description of Equipment	Quantity Required
1.	Personal Computers (Intel Core i3, 500GB, 8 GB RAM)	30
2.	Printer	1
3.	Software: Oracle Virtual Box, Ubuntu Guest OS, GAE, Docker, Cloud Sim, Java NetBeans, Hadoop, Openstack	30

Course Code	Course Name	L	T	P	C
VCS336	**MULTICORE ARCHITECTURE**	**3**	**0**	**0**	**3**

Category: Professional Elective Course

a. Preamble

This course enables the students to understand the importance of multi-core architectures. This course cultivates the practice of writing efficient parallel programs which are executed by multi-core processors.

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Explain the fundamental concepts of multi-core processors	K2
CO2	Summarize the issues in programming Parallel Processors	K2
CO3	Build parallelized programs using MPI	K3
CO4	Develop parallelized programs using OpenMP	K3
CO5	Compare programming for serial and parallel processors	K2

c. Course Syllabus   **Total : 45 Periods**

MULTI-CORE PROCESSORS   **9**

Single core to Multi-core architectures – SIMD and MIMD systems – Cache coherence - Symmetric and Distributed Shared Memory Architectures – Caveats - Shared-memory - Distributed-memory - Programming hybrid systems. Performance Issues – Speedup and efficiency – Amdahl's law - Parallel program design.

PARALLEL PROGRAM CHALLENGES   **9**

Defining performance – How structure impacts performance – The role of the compiler – Synchronization and data sharing – Data races – Deadlocks and Livelocks – Communication between threads and processes.

DISTRIBUTED MEMORY PROGRAMMING WITH MPI   **9**

Introduction - The Trapezoidal Rule in MPI - Collective communication – MPI derived data types – Performance evaluation – A parallel sorting algorithm.

SHARED MEMORY PROGRAMMING WITH OpenMP 9

Introduction - Compiling and running OpenMP programs - The Trapezoidal Rule – Scope of variables - The Reduction Clause - The parallel for Directive - Handling Loops.

PARALLEL PROGRAM DEVELOPMENT 9

Case studies – Two n-Body solvers – Tree Search – OpenMP and MPI implementations and comparison.

d. Activities

Students shall be exposed to the parallelization of C programs using OpenMP and MPI.

e. Learning Resources

Text Books

1. Peter S Pacheco, *An Introduction to Parallel Programming*, Morgan-Kauffman/Elsevier, 2011.

2. Darryl Gove, *Multicore Application Programming for Windows, Linux, and Oracle Solaris*, Pearson Education, 2011.

Reference Books

1. Michael J Quinn, *Parallel programming in C with MPI and OpenMP*, Tata McGraw Hill, 2003.

2. Victor Alessandrini, Ken Burbary, *Shared Memory Application Programming: Concepts and Strategies in Multicore Application Programming*, 1st Edition, Morgan Kaufmann, 2015.

3. Yan Solihin, *Fundamentals of Parallel Multicore Architecture,* CRC Press, 2015.

Course Code	Course Name	L	T	P	C
VCS337	**DISTRIBUTED SYSTEMS**	**3**	**0**	**0**	**3**

Category: Professional Elective Course

a. Preamble

The course enables the students to understand the fundamental principles and models underlying all aspects of distributed computing. The course addresses the principles underlying the theory, algorithms, systems aspects and practical systems-like problems of distributed computing.

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Explain the foundations and issues of distributed systems	K2
CO2	Outline the various synchronization issues and global state for distributed systems	K2
CO3	Explain the mutual exclusion and deadlock detection algorithms in distributed systems	K2
CO4	Summarize the agreement protocols and fault tolerance mechanisms in distributed systems	K2
CO5	Illustrate the features Content Delivery Networks	K2

c. Course Syllabus   **Total : 45 Periods**

INTRODUCTION   **9**

Introduction – Message-passing systems versus shared memory systems –Primitives for distributed communication –Synchronous versus asynchronous executions –Design issues and challenges. A model of distributed computations –Global state– Cuts – Past and future cones of an event –Models of process communications. Logical Time: A framework for a system of logical clocks –Scalar time –Vector time – Physical clock synchronization: NTP.

MESSAGE ORDERING AND SNAPSHOTS   **9**

Message ordering and group communication: Message ordering paradigms –Asynchronous execution with synchronous communication –Synchronous program order on an asynchronous system –Group communication – Causal order (CO) - Total order. Global state and snapshot recording algorithms: Introduction –System model and definitions –Snapshot algorithms for FIFO channels.

DISTRIBUTED MUTEX AND LOCKS   9

Distributed mutual exclusion algorithms: Introduction – Preliminaries – Lamport's algorithm –Ricart-Agrawala algorithm – Maekawa's algorithm – Suzuki–Kasami's broadcast algorithm. Deadlock detection in distributed systems: Introduction – System model – Preliminaries – Models of deadlocks – Knapp's classification – Algorithms for the single resource model, the AND model and the OR model.

RECOVERY AND CONSENSUS   9

Check pointing and rollback recovery: Introduction – Background and definitions – Issues in failure recovery – Checkpoint-based recovery – Log-based rollback recovery – Coordinated check pointing algorithm – Algorithm for asynchronous check pointing and recovery. Consensus and agreement algorithms: Problem definition – Overview of results – Agreement in a failure –free system – Agreement in synchronous systems with failures.

CONTENT DELIVERY NETWORKS AND P2P   9

Content Delivery Networks – Identifying the content – Key Delivery Methods : Peer-to-peer systems - Introduction – Data indexing and overlays – Chord –Content addressable networks – Initialization –Routing – Maintenance – Optimization – Tapestry – Delivery Performance and Quality.

d. Activities

Students shall be exposed to the fundamental principles and practical systems-like problems of distributed computing

e. Learning Resources

Text Books

1. Ajay D Kshemkalyani and Mukesh Singhal, *Distributed computing: principles, algorithms, and systems*, Cambridge University Press, 2011.

2. George Coulouris, Jean Dollimore and Tim Kindberg, *Distributed Systems Concepts and Design*, 5th Edition, Pearson Education, 2012.

Reference Books

1. Pradeep K Sinha, *Distributed Operating Systems: Concepts and Design*, Prentice Hall of India, 2000.

2. Tanenbaum, AS and Van Steen, M, *Distributed Systems: Principles and Paradigms*, Pearson Education, 2007.

3. Liu, ML, *Distributed Computing, Principles and Applications*, Pearson Education, 2004.

Course Code	Course Name	L	T	P	C
VCS341	**MULTIMEDIA SYSTEMS**	**3**	**0**	**0**	**3**

Category: Professional Elective Course

a. Preamble

This course enables the students to be familiar with the basics of multimedia systems, gain knowledge in multimedia tools and authoring, infer multimedia compression techniques, acquire knowledge in the area of multimedia communication systems and explore popular multimedia application areas.

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Outline the characteristics and formats of multimedia elements.	K2
CO2	Apply multimedia tools for Editing and Authoring multimedia applications.	K3
CO3	Interpret the Compression algorithms for appropriate multimedia applications.	K2
CO4	Demonstrate effective strategies to deliver Quality-of-Experience in Networked Multimedia applications.	K2
CO5	Develop the multimedia applications in prominent domains.	K3

c. Course Syllabus **Total : 45 Periods**

MULTIMEDIA ELEMENTS **9**

Principles –Digital Audio – Characteristics, formats, standards, Speech, Video-characteristics, formats; Animation – characteristics, formats; Multidimensional Data Structures, k-d trees, Quad Trees, R-trees.

MULTIMEDIA TOOLS AND AUTHORING **9**

Hardware – Display Devices, wearables, Graphics cards, I/O devices, software – Editing tools for Text, Image, Audio, Video and animation - Authoring tools - Authoring Multimedia presentations - Authoring Metaphors.

MULTIMEDIA COMPRESSION 9

Symmetric and Asymmetric methods - Lossy and Lossless Compression - Text compression - RLE - Huffman – Document Image compression standards - CCITT and Color Image Compression – JPEG, Audio Compression – PCM– MPEG – speech compression - Video Compression - MPEG-4 - H.265.

MULTIMEDIA COMMUNICATION SYSTEMS 9

Multimedia Communication Standards - Streaming protocols - Internet Protocols Wireless multimedia communications - Synchronization and QoS, Security - Entertainment networks - Collaborative multimedia support - Real-time distributed multimedia networks – Hypertext - Hypermedia.

SMART MULTIMEDIA APPLICATIONS 9

Blogs and Vlogs - Social Media – Visualization – Virtual, Augmented and Mixed   Reality - Interactive E-learning - HCI and UX design - Games and Animation - Real-Time Video conferencing.

d. Activities

Students shall be exposed to do the mini projects in multimedia systems.

e. Learning Resources

Text Books

1. Ze-Nian Li, Mark S Drew and Jiangchuan Liu, *Fundamentals of Multimedia*, 2nd Edition, Springer Nature (Texts in Computer Science) , 2014.

2. Prabhat K Andleigh & KiranThakrar, *Multimedia Systems Design,* 1st Edition, Pearson Education India, 2015.

3. Ralf Steinmetz & Klara Nahrstedt, *Multimedia computing, communication and applications*, Pearson India, 2014.

Reference Books

1. Fred Halsall, *Multimedia Communications: Applications, Networks, Protocols and Standards*, Pearson Education, 2012.

2. Khalid Sayood, *Introduction to Data Compression*, 4th Edition, Morgan Kauffman, 2012.

3. Rao, KR, Zoran S Bojkovic, Bojan M and Bakmaz, *Wireless Multimedia Communication systems: Design, Analysis and Implementation*, CRC press.

4. Subrahmanian VS, *Principles of Multimedia Database Systems*, Elsevier / Morgan Kauffmann, 2017.

Course Code	Course Name	L	T	P	C
VCS342	**IMAGE PROCESSING**	**3**	**0**	**0**	**3**

Category: Professional Core Course

a. Preamble

This course enables the students to understand the basic concepts about image processing.
The students get familiarized with the image processing techniques and colour models.
This course focuses on various morphological image processing methods.

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Explain sensing, acquisition and storage of digital images	K2
CO2	Illustrate the concepts of digital processing systems and the basic image transformation domains and methods	K2
CO3	Explain the colour models, type of image representations	K2
CO4	Apply image compression procedures to the real world problems	K3
CO5	Identify the suitable image segmentation and representation techniques to solve the domain problems.	K3

c. Course Syllabus   **Total : 45 Periods**

DIGITAL IMAGE FUNDAMENTALS   **9**

Introduction of Coordinate representation and Pixel - Steps in Digital Image Processing - Image processing system components - Elements of Visual Perception - Image sensing and acquisition - Sampling and quantization - Neighbors of pixel adjacency connectivity - Distance measures

IMAGE ENHANCEMENT&IMAGE RESTORATION   **9**

Frequency and Spatial Domain - Contrast Stretching - Histogram Equalization - Low pass and High pass filtering - Noise models - Mean, order - Statistics - Adaptive filters

COLOUR IMAGE PROCESSING   **9**

Colour models - Pseudo colour Image processing - Colour transformation and segmentation

IMAGE COMPRESSION 9

Fundamentals - Models - Error free and lossy compression – Compression standards

MORPHOLOGICAL IMAGE PROCESSING 9

Boundary extraction - Region filtering - Connected component extraction - Convex hull - Thinning; Thickening; skeletons; pruning; Image segmentation.

d. Activities

Students shall be exposed to the core concepts of image processing using case study.

e. Learning Resources

Text Books

1. Rafel C. Gonzalez and Richard E. Woods, *Digital Image Processing*, 3rd Edition, Pearson Education, 2018.

Reference Books

1. Bhabatosh Chanda and Dwijesh Majumder, *Digital Image Processing*, 2nd Edition, PHI, 2010.
2. Anil K Jain, *Fundamentals of Digital Image Processing*, 2nd Edition, PHI, 2012.
3. Rafel C. Gonzalez and Richard E. Woods, *Digital Image Processing Using MATLab,* 4th Edition, PHI, 2018.

Course Code	Course Name	L	T	P	C
VCS343	**GAME DESIGN TECHNIQUES**	**2**	**0**	**2**	**3**

Category: Professional Elective Course (Theory cum Lab)

a. Preamble

This course enables the students to understand the game programming concepts to design attractive games and it enriches the logical skills of the students to develop and design the game.

b. Course Outcome (Theory)

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Explain the concepts of game design and development	K2
CO2	Illustrate the game development mechanism	K2
CO3	Outline the architectures of game Programming and event management	K2
CO4	Utilize Game programming platforms, frame works and engines	K3
CO5	Construct interactive Games	K3

Course Outcome (Lab)

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Demonstrate the basic steps and animations in Pygame and Pygame zero	K2
CO2	Develop Pygame routines and snake game	K3
CO3	Implement python codes to build a game	K3
CO4	Utilize unity platforms to create games	K3
CO5	Construct interactive Games in unity	K3

c. Course Syllabus   **Total : 60 Periods**

GAME DESIGN AND DEVELOPMENT   **6**

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

GAMING MECHANISM   **6**

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   **6**

Application layer - Game logic - Game views - Managing memory - Controlling main loop, loading and caching game data - User Interface management - Game event management.

GAMING PLATFORMS AND FRAMEWORKS   **6**

2D and 3D Game development using Flash – DirectX – Java – Python - Game engines-Unity-DX Studio.

INTERACTIVE GAME DEVELOPMENT   **6**

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

LIST OF LABORATORY EXPERIMENTS   **30**

1. Installation of Pygame, Pygame Zero and Implementation of colour models and shading models in Python
2. Implementation of simple animations in Pygame and Processing.py
3. Implementation of Pygame routines for character rendering, transformations and sound processing.
4. Construct a snake game using python.
5. Develop one multiplayer pong game using python.
6. Build a simple cookie clicker game using python.
7. Installation of Unity.
8. Construct a simple 2D game in unity
9. Develop a moving 2D objects in unity
10. Build a simple 3D game in unity.
11. Mini Project.

d. Activities

Students shall be exposed to game developing concepts and they can create simple games using Python and Unity.

e. Learning Resources

Text Books

1. Mike McShaffrfy and David Graham, *Game Coding Complete*, 4th Edition, Cengage Learning, PTR, 2013.

2. Jason Gregory, *Game Engine Architecture*, CRC Press / A K Peters, 2018.

3. David H. Eberly, *3D Game Engine Design, Second Edition: A Practical Approach to Real-Time Computer Graphics*, 2nd Edition, Morgan Kaufmann, 2023.

Reference Books

1. Ernest Adams and Andrew Rollings, *Fundamentals of Game Design*, 2nd Edition, Prentice Hall / New Riders, 2014.

2. Eric Lengyel, *Mathematics for 3D Game Programming and Computer Graphics*, 3rd Edition, Course Technology PTR, 2011.

3. Jesse Schell, *The Art of Game Design: A book of lenses*, 1st Edition, CRC Press, 2017.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

S.No.	Description of Equipment	Quantity Required
1.	Personal Computers (Intel Core i3, 250 GB, 4 GB RAM)	30
2.	Software: Python, Unity DX Studio	30

Course Code	Course Name	L	T	P	C
VCS344	**GRAPHICS MODELING AND SIMULATION**	**3**	**0**	**0**	**3**

Category: Professional Elective Course

a. Preamble

This course enables the students to understand the basic concepts of graphics modeling and animation. The students get familiarized with different 2D and 3D modeling techniques. This course enables the students to learn about different 3D texturing, rendering and various simulation techniques that are used for 3D object modeling.

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Explain the basic concepts of modeling and animation	K2
CO2	Apply 2D graphics modeling techniques	K3
CO3	Apply 3D modeling and animation techniques	K3
CO4	Explain about various texturing and rendering methods used for 3D graphics modeling	K2
CO5	Illustrate the usage of 3D simulation techniques in 3D graphics modeling	K2

c. Course Syllabus   **Total : 45 Periods**

INTRODUCTION TO MODELING, ANIMATION AND MAX INTERFACE   **9**

Introduction to Computer based animation - Basic types of animation: real time, non-real-time- Definition of modeling - Creation of 3D objects - Exploring the max interface, controlling & configuring the viewports - Customizing the max interface & setting preferences - Working with files - Importing & exporting, selecting objects - Duplicating objects - Creating & editing standard primitive and extended primitives objects - Transforming objects.

2D MODELING   **9**

Understanding 2D Splines & shape - Extrude & Bevel 2D object to 3D - Understanding Loft and terrain - Modeling simple objects with splines - Understanding morph, scatter, conform connect compound objects - Blob mesh – Boolean Proboolean and procutter compound object.

3D MODELING AND ANIMATION   10

Modeling with Polygons - Working with XRefs - Building complex scenes with XRefs using assets tracking - Deforming surfaces - Mesh modifiers - Modeling with patches and NURBS - Creating Key frames - Move & Scale keyframe on the timeline - Simple and complex controllers, Animation modifiers - Camera effects - Configuring & Aiming cameras - Camera 34 motion blur – Camera tracking - Working with advanced lighting - Light tracing – Radiosity.

3D TEXTURING AND RENDERING   9

Using material editor and the material explorer - Creating and applying standard materials - adding material details with maps - Creating compound materials and material modifiers - Unwrapping UVs & mapping texture - Rendering with V-Ray - V-ray light setup - V-ray rendering settings – HDRI Illumination - Fine-tuning shadows.

3D SIMULATION   8

Bind to Space Warp object - Gravity, wind, displace force object – Deflectors - FFD space warp, wave, ripple, bomb - Creating particle system through parray - Understanding particle flow user interface – Working principle of particle flow – Hair and fur modifier - Cloth and garment maker modifiers.

d. Activities

Students shall be exposed to the core concepts of graphics modeling using case study.

e. Learning Resources

Text Books

1. Michael E Mortenson, *3D Modelling, Animation, and Rendering: An Illustrated Lexicon, Black and White Edition*, Create space publishers, 2010.
2. Boardman Ted, *3dsmax 7 Fundamentals*, Pearson Education, 2014.

Reference Books

1. Boris Kulagin, *3ds Max 8 from Modelling to Animation*, BPB publishers, 2008.
2. Michael G, *3D Modelling and Animation*, IGI Publishers, 2004.
3. Lance Flavell, *Beginning Blender: Open Source 3D Modelling, Animation, and Game Design*, Apress publishers, 2010.

Course Code	Course Name	L	T	P	C
VCS345	VISUAL EFFECTS	3	0	0	3

Category: Professional Elective Course

a. Preamble

This course enables the students to understand the basic concepts of Visual Effects (VFX) and usage of video editing software to obtain seamless shots and create standard projects.

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Explain the visual effects and its techniques.	K2
CO2	Illustrate the VFX acquisition and shooting elements.	K2
CO3	Build motion capture and its types.	K3
CO4	Construct 3D Stereoscopic design and its workflow.	K3
CO5	Apply the concept of Digital Element Creation.	K3

c. Course Syllabus   **Total : 45 Periods**

INTRODUCTION TO VISUAL EFFECTS   **9**

Introduction – Visual Effects and Special Effects - Designing the Visual Effects Shots - Visual Effects Techniques – Previs - Development of Previs Techniques – Postvis- Applications.

ACQUISITION AND SHOOTING   **9**

Working with the Visual Effects - Front and Rear Projection Systems for Visual Effects - On-Set Data Acquisition - Filming Live - Action Plates to be Used in VFX - Shooting Elements for Compositing - High - Speed Photography and Filming Elements.

PERFORMANCE AND MOTION CAPTURE   **9**

Motion Capture - Types - Preparing for Motion Capture - Hardware – Software - Facial Capture – Real - Time Motion.

STETREOSCOPIC 3D   **9**

Working of 3D – Stereoscopic Design - Virtual 3D Photography - 2D to 3D Conversion - 3D Stereoscopic Visual Effects - 3D Stereo Digital Intermediate Workflow.

DIGITAL ELEMENT CREATION 9

Digital Modeling - Texturing and Surfacing – Digital Feathers - Dynamics and Simulation - Digital Lighting - 3D Compositing.

d. Activities

Students shall be exposed to develop a visual effects pipeline for integration in the film making process.

e. Learning Resources

Text Book

1. Jeffery Okun and Susan Zwerman, *The VES Handbook of Visual Effects: Industry Standard VFX Practices and Procedures*, 3rd Edition, Focal Press, 2014.

Reference Books

1. Ron Brinkmann, *The Art and Science of Digital Compositing: Techniques for Visual Effects, Animation and Motion Graphics*, 2nd Edition, Elsevier edition, 2008.

2. Wallace Jackson, *VFX Fundamentals: Visual Special Effects Using Fusion 8.0*, Apress, 2016.

Course Code	Course Name	L	T	P	C
VCS346	**EMERGING ADVANCEMENTS IN AUGMENTED REALITY AND VIRTUAL REALITY**	2	0	2	3

Category: Professional Elective Course (Theory cum Lab)

a. Preamble

This course enables the students to understand the basic concepts and framework of virtual reality. The students get familiarized with the relevance of virtual reality concept, virtual reality methodology and virtual reality environment. This course empowers the students to design virtual reality on the web and mobile to demonstrate engineering applications. This course focuses on understanding the augmented reality methodology and demonstration of the basic functionalities of augmented reality.

b. Course Outcome (Theory)

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Demonstrate the basic concepts and framework of virtual reality.	K2
CO2	Outline the relevance of virtual reality concept, methodology, and environment.	K2
CO3	Develop web and mobile applications using virtual reality.	K3
CO4	Organize the augmented reality methodology.	K3
CO5	Develop the applications using augmented reality.	K3

Course Outcome (Lab)

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Build and deploy a Virtual Reality application.	K3
CO2	Develop a comfortable, high-performance VR application using Unity.	K3
CO3	Identify, examine and develop software that reflects fundamental techniques for the design and deployment of VR experiences.	K3
CO4	Develop Augmented Reality apps in Unity.	K3
CO5	Apply the knowledge of AR technologies in building of the virtual environment and modalities of interaction and modelling.	K3

c. Course Syllabus   **Total : 60 Periods**

INTRODUCTION   6

The three I's of virtual reality - Commercial Virtual Reality technology and the five classic components of a Virtual Reality system - Input Devices: Trackers and Navigation - Output Devices: Graphics displays - Sound displays & Haptic feedback.

VIRTUAL REALITY DEVELOPMENT PROCESS   6

Geometric modeling - Kinematics modeling - Behaviour modeling - Virtual Reality health and safety issues - Usability of virtual reality system - Cyber sickness.

VIRTUAL REALITY ON THE WEB & MOBILE   6

JS - pros and cons - building blocks (WebVR, WebGL, Three.js, device orientation events) - Frameworks (A-frame, React VR) - Google Virtual Reality for Android -   Mobile device configuration.

INTRODUCTION TO AUGMENTED REALITY   6

Taxonomy - Technology and features of augmented reality - Difference between AR and VR- Augmented reality methods - Visualization techniques for augmented reality - wireless displays in educational augmented reality applications.

AUGMENTED REALITY DEVLOPEMENT PROCESS   6

Connecting Context and Content in AR System - Content Rendering in AR – Extended Reality - Rendering 2D content - Rendering 3D content - 3D models -AR Application Areas.

LIST OF LABORATORY EXPERIMENTS   30

1. Installation of Unity and Visual Studio, setting up Unity for VR development.
2. Exploring Unity tool using simple applications
3. Design of an AR application with Unity
4. Use the primitive objects and apply various projection types by handling camera.
5. Application of various lighting and shading effects.
6. Addition of audio and text special effects to the developed application.
7. Model three dimensional objects using various modeling techniques and apply textures over them.
8. Mini Project

d. Activities

Students shall be exposed to the core concepts of Augmented and Virtual Reality using case study.

e. Learning Resources

Text Books

1. Burdea and Philippe Coiffet, *Virtual Reality Technology*, 2nd Edition, Gregory, John Wiley & Sons, Inc, 2008.

2. Alan B Craig, *Understanding Augmented Reality Concepts and Applications*, Morgan Kaufmann, 2013.

Reference Books

1. Dieter Schmalstieg and Tobias Hollerer, *Augmented Reality: Principles and Practice (Usability)",* Pearson Education (US), Addison - Wesley Educational Publishers Inc, New Jersey, United States, 2016.

2. Jason Jerald, *The VR Book: Human-Centred Design for Virtual Reality,* Association for Computing Machinery and Morgan & Claypool, New York, NY, USA, 2015.

3. Steve Aukstakalnis, *Practical Augmented Reality: A Guide to the Technologies, Applications and Human Factors for AR and VR (Usability)*, 1st Edition, Addison-Wesley Professional, 2016.

4. Tony Parisi, *Learning Virtual Reality: Developing Immersive Experiences and Applications for Desktop, Web, and Mobile*, 1st Edition, O'Reilly Media, 2015.

5. Tony Parisi, *Programming 3D Applications with HTML5 and WebGL: 3D Animation and Visualization for Web Pages*, 1st Edition, O'Reilly Media, 2014.

6. Jos Dirksen, *Learning Three.js: The JavaScript 3D Library for WebGL*, 2nd Edition, Packt Publishing, 2015.

7. Dieter Schmalstieg and Tobias Hollerer, *Augmented Reality: Principles & Practice,* Addison – Wesley Publishers, 2016.

8. Cawood, Augmented Reality: *A Practical Guide,* 1st Edition, Pragmatic Bookshelf Publisher, 2008.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

S.No.	Description of Equipment	Quantity Required
1.	Personal Computers (Intel Core i3, 250GB, 8 GB RAM)	30
2.	Software: Unity, C#, Blender, VR Toolkit	30
3.	VR Devices: HTC Vive, Google Cardboard, Google Daydream and Samsung gear VR.	30

Course Code	Course Name	L	T	P	C
VCS347	**DIGITAL MARKETING ESSENTIALS**	3	0	0	3

Category: Professional Elective Course

a. Preamble

This course enables the students to understand the importance of competitive strategies for the digital marketing. This course creates awareness on the concepts of digital marketing and its impact on modern business.

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Explain about comprehensive marketing plan by integrating digital marketing tactics.	K2
CO2	Demonstrate proficiency in using a variety of search engine optimization (SEO) tools.	K2
CO3	Utilize the knowledge of keyword research, ad creation, and bidding strategies for effective ad campaigns.	K3
CO4	Apply the knowledge of social media marketing and web analytics tools.	K3
CO5	Develop strategies for integrating email and affiliate marketing program to maximizing its impact on business.	K3

c. Course Syllabus   **Total : 45 Periods**

DIGITAL MARKETING   **9**

Introduction to Digital Marketing – History and evolution of digital marketing – Difference between traditional marketing and digital marketing– Types of digital marketing approaches - Importance of Digital Marketing - Strategy Building Process – The 4p's of Marketing (Product, Price, Place and Promotion) - Different platforms for digital advertising.

SEARCH ENGINE OPTIMIZATION   **9**

Inheritance Search Engine Optimization (SEO): Definition, working, techniques – ON Page SEO: Web Site Domain, Relevant Filenames, Design& Layout - Optimized Keywords, Metatags, Anchor, Title –OFF Page SEO: Content Writing, Verifying Web Site, Link Building – Mobile SEO Techniques - SEO Tools and Techniques.

GOOGLE ADWORDS AND PAY PER CLICK 9

Google Adwords – Expensive Keyword – Google Adwords Bidding Process, Bidding Methods – Conversion Optimizer and its working – Adwords Campaign– Determination of Quality score and rank in Google Ads, Advertising on Google Adwords - Pay Per Click(PPC): Introduction, PPC - Terminology – Creating a Keyword List - Setting Location & Language – PPC - Landing Pages and its types – Measuring Results.

SOCIAL MEDIA MARKETING AND WEB ANALYTICS 9

Social Media Marketing (SMM): Facebook Marketing, Twitter Marketing, Linkedin Marketing - Google plus Marketing, Pinterest Marketing - Video Marketing - Social Bookmaking - Introduction Web Analytics and its importance - Web Analytics Process– Google Analytics –Web Analytics – Optimization – Web Analytics Tools (Crazy Egg) - Key Metrics.

EMAIL MARKETING AND AFFILIATE MARKETING 9

Email Marketing Overview, Mailing List, Organizing the Mailing List– HTML & CSS Emails, Email Invitation, Email Content – Landing Pages, Spam Compliance – Email Automation and Metrics, Email Marketing Tips - Affiliate Marketing – History - Action and Reward – Tracking -Promote Merchants-Affiliate Networks, Case Study.

d. Activities

Students shall be exposed to Google Tag Manager and to create the Business Website.

e. Learning Resources

Text Books

1. Rob Stokes, *eMarketing: The Essential Guide to Digital Marketing*, 6th Edition, Quirk Education, 2018.

2. Damian Ryan and Calvin Jones, *Understanding DIGITAL Marketing: Marketing strategies for engaging the digital generation*, 3rd Edition, Kogan Page, 2016.

Reference Books

1. Brian Clifton, *Advanced Web metrics with Google Analytics*, 3rd Edition, Wiley Publication, 2012.

2. Chuck Hemann and Ken Burbary, *Digital Marketing Analytics*, 2nd Edition, Que Publication, 2018.

3. Jeffery Mark, *Data-Driven Marketing: The 15 Metrics Everyone in Marketing Should Know,* 1st Edition, Wiley Publication, 2010.

Course Code	Course Name	L	T	P	C
OCS781	**FUNDAMENTALS OF SOFTWARE ENGINEERING**	3	0	0	3

Category: Open Elective Course

a. Preamble

This course enables the students to understand the need and apply the software engineering principles in the software development process. The students get familiarized with the design of software requirements specification and management. This course also focuses on software projects and testing.

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Explain the software engineering principles for software development	K2
CO2	Explain the software requirements specification in the software development process	K2
CO3	Outline the software design concepts in the software development process	K2
CO4	Apply software testing techniques in software development process	K3
CO5	Identify software quality methods for developing the applications	K3

c. Course Syllabus **Total : 45 Periods**

SOFTWARE PROCESS AND DEVELOPMENT **9**

The nature of software – Software engineering practice – Software myths – Generic process models: prescriptive process models, specialized process models, the Unified Process (UP), personal and team process models – Overview of Agile process – Extreme Programming (XP) – Scrum model – Agile process Models.

REQUIREMENT ENGINEERING AND MODELING **9**

Functional and non-functional requirements – Software requirements document – Requirement Specification – Requirement engineering process – Requirements elicitation and analysis –

Requirements validation – Requirements Change – System modelling: Context models, Interaction models, Structural models, Behavioral models, Model – Driven engineering

DESIGN CONCEPTS 9

Design Concepts – Architectural design: software architecture, architectural styles, architectural design, architectural mapping using data flow – User interface design: the golden rules, user interface analysis and design steps – Design patterns – Pattern based software design – Architectural patterns

TESTING 9

Testing: strategic approach to software testing – Test strategies for conventional and object oriented software –Validation testing –System testing – Debugging – White box testing – Basis path testing – Control structure testing – Black box testing – Testing web applications

SOFTWARE QUALITY MANAGEMENT 9

Quality concepts – Review techniques – Software quality assurance – Software configuration management – Product metrics

d. Activities

Students shall be exposed to the concepts of software design and project development using case study.

e. Learning Resources

Text Books

1. Roger S. Pressman, *Software Engineering – A practitioner's approach*, 9th Edition, McGraw Hill Publications, 2019.

2. Ian Somerville, *Software engineering*, 10th Edition, Pearson Education Asia, 2017.

Reference Books

1. James F.Peters and Witold Pedrycz, *Software Engineering, an Engineering Approach*, Wiley-India, 2007.

2. Watts S.Humphrey, *A Discipline for Software Engineering,* Pearson Education, 2011.

3. Richard Fairley, *Software Engineering concepts*, 30th Reprint, McGraw-Hill International Edition, 2008.

4. Stephen R.Schach, *Software Engineering*, Tata McGraw-Hill, 2007.

5. S.A.Kelkar, *Software Engineering*, Prentice Hall of India, 2007.

a. Learning Resources

Text Book

1. Cay S Horstmann and Gary Cornell, *Core Java: Volume I – Fundamentals*, Prentice Hall, 10th Edition, 2015.

Reference Books

1. Herbert Schildt, *Java: The Complete Reference*, Eleventh Edition, McGraw Hill Education, 2014.

2. Paul Deitel, Harvey Deitel, *Java SE8 for Programmers*, Pearson Education, 3rd Edition, 2014.

3. P.J. Deitel & H.M. Deitel, *Java: How to Program Java 2*, Prentice Hall, 7th Edition, 2011.

Course Code	Course Name	L	T	P	C
MCS101	**FUNDAMENTALS OF DATA STRUCTURES**	**3**	**0**	**0**	**3**

Category: Open Elective (Minor Degree)

a. Preamble

This course focuses on fundamental concepts and techniques for designing and implementing various Abstract Data Types (ADT) and algorithms. This course enables the students to solve complex problems, which are essential for developing robust and efficient software applications.

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Explain the fundamentals of Data Structures and Algorithms	K2
CO2	Organize data using Linked lists	K3
CO3	Make use of Stack and Queue ADT for real-time applications	K3
CO4	Experiment with Tree ADT operations and applications	K3
CO5	Apply appropriate Sorting and Searching techniques for applications	K3

c. Course Syllabus   **Total: 45 Periods**

INTRODUCTION TO DATA STRUCTURES   **9**

Control Structures – Arrays – Pointers – Data Structures - Classification of Data Structures – Abstract Data Type.

LISTS   **9**

List ADT - Singly Linked List - Doubly Linked List.

STACK AND QUEUE   **9**

Stack ADT: Array Implementation, Linked list Implementation - Queue ADT: Array Implementation, Linked list Implementation.

TREES 9

Tree Terminologies – Types – Binary Tree – Operations – Binary Tree Traversals - Binary Search Tree.

SEARCHING AND SORTING 9

Searching: Linear Search – Binary Search – Sorting: Selection Sort - Insertion Sort – Merge Sort.

d. Activities

Students shall able to develop applications using Linear and Non-linear Data Structures and solve computational problems efficiently.

e. Learning Resources

Text Books

1. Amol M Jagtap and Ajit S Mali, *Data Structures using C: A Practical Approach for Beginners,* CRC Press, Taylor & Francis Group, 2022.

2. Bose, *Data Structures and Program Design in C,* 1st Edition, Evincepub Publishing, 2022.

Reference Books

1. Hemant Jain, *Problem Solving in Data Structures & Algorithms Using C,* 3rd Edition, Taran Technologies Private Limited, 2022.

2. William Smith, *Everyday Data Structures,* Packt Publishing Limited, 2017.

3. Reema Thareja, *Data Structures Using C*, 2nd Edition, Oxford University Press, 2014.

Course Code	Course Name	L	T	P	C
MCS102	**DATABASE ESSENTIALS**	**3**	**0**	**0**	**3**

Category: Open Elective (Minor Degree)

a. Preamble

This course enables the students to learn the fundamentals of data models and represent a database system using Entity Relationship (ER) diagrams and study Structured Query Language (SQL) and relational database design. This course enriches the knowledge of internal storage structures using different file, transaction processing concurrency control techniques, and recovery procedures, and learn about file organization and query processing.

b. Course Outcome

CO. No.	Course Outcome	Knowledge Level
CO1	Build the models using ER diagram for real-time applications	K3
CO2	Identify appropriate SQL commands to store and access data from Relational Database	K3
CO3	Construct a normalized database for real-world scenarios using functional dependencies	K3
CO4	Apply concurrency control mechanism in transactions to maintain consistency in a database	K3
CO5	Apply query optimization techniques to write query that produce quick and accurate results	K3

c. Course Syllabus   **Total: 45 Periods**

INTRODUCTION TO DATABASE AND ER MODEL   **9**

Fundamentals of Databases – Database System Architecture – ER Model – ER Diagrams **-** ER to Relational Schema Mapping.

RELATIONAL MODEL AND SQL   **9**

Structure of Relational Databases – SQL queries - Simple Queries, Aggregate Functions, Nested Queries, Joins.

NORMALIZATION   **9**

Pitfalls in Bad Relational database design - Functional Dependencies - Closure of Attributes- Normal Forms.

CONCURRENCY CONTROL AND TRANSACTION RECOVERY   **9**

Basics of Transactions - Need for concurrency control and recovery - Transaction Recovery - Serializability - Concurrency Control Lock-Based Protocols.

FILE ORGANIZATION AND QUERY PROCESSING   **9**

Organization of Records in Files - Query Processing - Query Tuning - Query Optimization.

d. Activities

Students are able to develop ER models and solve queries for various real-time applications.

e. Learning Resources

Text Book

1. Abraham Silberschatz, Henry F Korth, and Sudharshan S, *Database System Concepts*, 7th Edition, Tata McGraw Hill, 2020.

Reference Books

1. Ramez Elmasri and Shamkant B Navathe, *Fundamentals of Database Systems*, 6th Edition, Pearson Education, 2011.

2. Raghu Ramakrishnan, *Database Management Systems*, 4th Edition, McGraw-Hill College Publications, 2015.

3. Gupta G K, *Database Management Systems*, Tata McGraw Hill, 2011.

4. Date C J, A. Kannan and Swamynathan S, *An Introduction to Database Systems*, 8th Edition, Pearson Education, 2006.

Course Code	Course Name	L	T	P	C
MCS103	**FUNDAMENTALS OF JAVA PROGRAMMING**	**2**	**0**	**2**	**3**

Category: Open Elective (Minor Degree)

a. Preamble

This course enables the students to understand Object Oriented Programming concepts and basic characteristics of JAVA. This course enhances programming skill using inheritance and interfaces. This course enables the students to use exception handlers for developing JAVA applications. This course helps the students to build a JAVA applications using I/O streams and multithreading programming

b. Course Outcome (Theory)

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Demonstrate the basic concepts of object oriented programming using JAVA.	K2
CO2	Develop a simple JAVA application using class and object.	K3
CO3	Utilize the OOPs concept and non-access modifiers to solve real world problems.	K3
CO4	Choose an appropriate exception handler and I/O stream class for developing a JAVA application.	K3
CO5	Apply multithreading programming to generate synchronized threads.	K3

Course Outcome (Lab)

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Develop JAVA applications using fundamental programming Structures.	K3
CO2	Create JAVA applications using classes and object concept.	K3
CO3	Utilize the OOPs features to implement various JAVA applications.	K3
CO4	Apply the exception handling mechanism to handle the exceptions that arise in JAVA applications.	K3
CO5	Implement multithreaded programming for developing JAVA applications.	K3

c. Course Syllabus   **Total : 60 Periods**

INTRODUCTION   6

Introduction to Object Oriented Programming: Abstraction, Objects and Classes, Encapsulation, Inheritance, Polymorphism – Introduction to JAVA: Characteristics of Java, The Java Environment, Java Source File Structure, Compilation – Fundamental Programming Structures in Java: Data type and Variables, Operators, Decision making and Looping –

CLASS AND OBJECT   6

Classes: Predefined class, User defined class, Access modifiers – Object: Object reference, Object cloning, Reflection – Methods: Types of method definition – Arrays – Strings – Constructor: Default constructor, Parameterized constructor – Package: Predefined package, util package, Understanding class path, User defined package – Javadoc comments.

INHERITANCE AND POLYMORPHISM   6

Inheritance: Single Inheritance, Multilevel Inheritance, Hierarchical Inheritance, Super keyword – Interface – Polymorphism: Method overloading, Method overriding – Non-Access modifiers: Abstract class and method, Static keyword, Final keyword.

EXCEPTION HANDLING AND I/O STREAMS   6

Exception Handling: Garbage collection, Finalize() method, Throwable interface, Types of exception, Exception handlers: Try, Catch, Finally, Throw, Throws, User define exception – Input and Output: Byte stream, Character stream, Reading and writing from console and files.

MULTITHREADING PROGRAMMING   6

Multithreading: Thread states, Thread life cycle, Thread properties, Thread priorities, Thread synchronization.

PRACTICAL EXERCISES: 30

1. Implementation of Basic Java programs

   a. Make use of appropriate control statements

   i. To perform linear search

   ii. To perform matrix operations

   iii. To generate prime numbers

   iv. Pattern printing – Floyd's triangle

2. Implementation of Java program using classes and object

Develop a Java application to generate Electricity bill. Create a class with the following members: Consumer no., consumer name, previous month reading, current month reading, type of EB connection (i.e domestic or commercial). Compute the bill amount using the following tariff.

    i. If the type of the EB connection is domestic, calculate the amount to be paid as follows:

- First 100 units – Rs. 1 per unit
- 101-200 units – Rs. 2.50 per unit
- 201 -500 units – Rs. 4 per unit
- \> 501 units – Rs. 6 per unit

    ii. If the type of the EB connection is commercial, calculate the amount to be paid as follows:

- First 100 units – Rs. 2 per unit
- 101-200 units – Rs. 4.50 per unit
- 201 -500 units – Rs. 6 per unit
- \> 501 units – Rs. 7 per unit

3. Implementation of user defined Packages.

    a. Develop a Java application to implement currency converter (Dollar to INR, EURO to INR, Yen to INR and vice versa), distance converter (meter to KM, miles to KM and vice versa) , time converter (hours to minutes, seconds and vice versa) using packages.

4. Implementation of Inheritance concepts

    a. Develop a Java application with Employee class with Emp_name, Emp_id, Address, Mail_id, Mobile_no as members. Inherit the classes, Programmer, Assistant Professor, Associate Professor and Professor from employee class. Add Basic Pay (BP) as the member of all the inherited classes with 97% of BP as DA, 10 % of BP as HRA, 12% of BP as PF, 0.1% of BP for staff club fund. Generate pay slips for the employees with their gross and net salary.

5. Implementation of Interfaces concept

    Design a Java interface for ADT Stack. Implement this interface using array. Provide necessary exception handling in both the implementations.

6. Implement a Java program that make use of Non access modifiers

   a. Write a Java Program to create an abstract class named Shape that contains two integers and an empty method named print Area().

      - Provide three classes named Rectangle, Triangle and Circle such that each one of the classes extends the class Shape.

      - Each one of the classes contains only the method print Area () that prints the area of the given shape.

7. Implement a Java program using various Exception handling

   a. Write a Java program to use exception handlers

8. Files and IO streams.

   a. Write a Java program that reads a file name from the user, displays information about whether the file exists, whether the file is readable, or writable, the type of file and the length of the file in bytes.

9. Implementation of Multithreading programming

   a. Write a java program that implements a multi-threaded application that has three threads.

      i. First thread generates a random integer every 1 second and if the value is even

      ii. Second thread computes the square of the number and prints. If the value is odd

      iii. Third thread will print the value of cube of the number.

d. Learning Resources

Text Book

1. Cay S Horstmann and Gary Cornell, *Core Java: Volume I – Fundamentals*, Prentice Hall, 10th Edition, 2015.

Reference Books

1. Herbert Schildt, *Java: The Complete Reference*, Eleventh Edition, McGraw Hill Education, 2014.

2. Paul Deitel, Harvey Deitel, *Java SE8 for Programmers*, Pearson Education, 3rd Edition, 2014.

3. P.J. Deitel & H.M. Deitel, *Java: How to Program Java 2*, Prentice Hall, 7th Edition, 2011.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

S.No.	Description of Equipment	Quantity Required
1.	Personal Computers (Intel Core i3, 500GB, 4 GB RAM)	30
2.	Printer	1
3.	Software: Netbeans IDE, JAVA	30

Course Code	Course Name	L	T	P	C
MCS104	**INTRODUCTION TO DATA SCIENCE**	**3**	**0**	**0**	**3**

Category: Open Elective (Minor Degree)

a. Preamble

This course enables the students to understand the basic concepts of data science fundamentals and processes. The students get familiarized to utilize the Python libraries for Data Wrangling. This course focuses on interpreting data using visualization libraries in Python

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Summarize the process of data exploration and data analysis	K2
CO2	Illustrate various types of data and variables used for data description	K2
CO3	Demonstrate statistics techniques used for correlation and regression problems	K2
CO4	Apply Data transformation techniques to simplify and slice the data	K3
CO5	Choose different forms of the chart and map to visualize and insight into the data	K3

c. Course Syllabus

Total: 45 Periods

FUNDAMENTALS OF DATA SCIENCE

9

Data Science: Benefits and uses – facets of data - Data Science Process: Overview – Defining research goals – Retrieving data – Data preparation - Exploratory Data analysis – Building the model– Presenting findings and building applications - Data Mining - Data Warehousing – Basic Statistical descriptions of Data.

DATA DESCRIPTION 9

Types of Data - Types of Variables - Describing Data with Tables and Graphs – Describing Data with Averages - Describing Variability - Normal Distributions and Standard Scores.

STATISTICS BASICS 9

Correlation – Scatter plots – Correlation coefficient for quantitative data – Computational formula for correlation coefficient – Regression – Regression line – Least squares regression line – Standard error of estimate – Interpretation of r2 – Multiple regression equations – Regression towards the mean.

DATA WRANGLING 9

Basics of Numpy arrays – Aggregations – Computations on arrays – Comparisons, masks, boolean logic – Fancy indexing – Structured arrays – Data manipulation with Pandas – Data indexing and selection – Operating on data – Missing data – Hierarchical indexing – Combining datasets – Aggregation and grouping – Pivot tables.

DATA VISUALIZATION 9

Importing Matplotlib – Line plots – 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.

d. Activities

Students shall be exposed to solving real-time problems using python libraries

e. Learning Resources

Text Books

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

2. Robert S Witte and John S Witte, *Statistics*, 11th Edition, Wiley Publications, 2017.

3. Jake Vander Plas, *Python Data Science Handbook*, O'Reilly, 2022.

Reference Book

1. Allen B Downey, *Think Stats: Exploratory Data Analysis in Python*, 2nd Edition, Green Tea Press, 2016.

Course Code	Course Name	L	T	P	C
MCS105	**ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING**	3	0	0	3

Category: Open Elective (Minor Degree)

a. Preamble

This course enables the students to understand the basic concepts of uninformed and Heuristic search techniques. The students get familiarized with the reasoning techniques under uncertainty. This course focuses on various supervised and unsupervised machine learning algorithms and the basics of deep learning using neural networks.

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Identify appropriate search techniques for problem-solving agent	K3
CO2	Apply reasoning techniques under an uncertain environment	K3
CO3	Solve real time problems using classification algorithms	K3
CO4	Choose ensembling and unsupervised models for real-time applications	K3
CO5	Apply neural network models for real time applications	K3

c. Course Syllabus   **Total: 45 Periods**

SEARCH ALGORITHMS FOR PROBLEM-SOLVING   **9**

Introduction to Artificial Intelligence (AI) - Problem-solving agents – Informed search strategies – Uninformed search strategies.

PROBABILISTIC REASONING   **9**

Acting under uncertainty –Bayesian inference – Probabilistic reasoning - Bayesian Networks (BN) – Inference in BN.

SUPERVISED LEARNING   **9**

Introduction to Machine Learning – Linear Regression - Multivariate Regression - Logistic regression – Decision Tree – Naive Bayes-kNN.

ENSEMBLING TECHNIQUES AND UNSUPERVISED LEARNING   9

Ensemble learning: Random Forest – Ada Boosting - Unsupervised Learning: Partition Clustering - Hierarchical Clustering.

NEURAL NETWORK MODELS   9

Activation functions - Perceptron - Multilayer perceptron - Backpropagation

d. Activities

Students shall be exposed to the core concepts of Artificial Intelligence and Machine Learning using case studies.

e. Learning Resources

Text Books

1. Stuart Russell and Peter Norvig, *Artificial Intelligence – A Modern Approach*, 4th Edition, Pearson Education, 2021.

2. Sridhar S and Vijayalakshmi M, *Machine Learning,* 1st Edition, Oxford University Press, 2021.

Reference Books

1. Philip C Jackson, *Introduction to Artificial Intelligence,* 3rd Edition, Dover Publications, 2019.

2. Mehryar Mohri, Afshin Rostamizadeh, and Ameet Talwalkar, *Foundations of Machine Learning*, 2nd Edition, MIT Press, 2018.

3. Deepak Khemani, *Artificial Intelligence*, Tata McGraw Hill Education, 2014.

4. Ethem Alpaydin, *Introduction to Machine Learning*, 4th Edition, MIT Press, 2020.

5. Mehryar Mohri, Afshin Rostamizadeh and Ameet Talwalkar, *Foundations of Machine Learning*, MIT Press, 2012.

Course Code	Course Name	L	T	P	C
MCS106	**CLOUD COMPUTING AND ITS APPLICATIONS**	3	0	0	3

Category: Open Elective (Minor Degree)

a. Preamble

This course enables the students to understand the concept and issues of cloud and utility computing. This course familiarizes the types of virtualizations. This course makes the students to have knowledge on various cloud service models. This course disseminates various cloud software and computing platforms. This course disseminates various cloud platforms.

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Outline the evolution of cloud Computing, its principles and characteristics	K2
CO2	Summarize the basic concepts and implementation levels of virtualization	K2
CO3	Illustrate the architecture, services and delivery models of cloud	K2
CO4	Identify the core issues of resource management and security in cloud computing	K2
CO5	Demonstrate the features of various platforms	K2

c. Course Syllabus   **Total : 45 Periods**

INTRODUCTION   **9**

Cloud Computing Basics: Introduction to Cloud Computing – Roots of Cloud Computing – Desired Features of Cloud Computing – Challenges and Risks – Benefits and Disadvantages of Cloud Computing.

VIRTUALIZATION   **9**

Introduction to Virtualization Technology – Load Balancing – Types of Virtualization – Implementation Levels of Virtualization – Server, Desktop, Application Virtualization.

CLOUD ARCHITECTURE AND SERVICES   **9**

Cloud Architecture: NIST Cloud Computing Reference Architecture – Architectural Design Challenges – Cloud Services: Public, Private and Hybrid Clouds – IaaS – PaaS – SaaS.

CLOUD RESOURCE MANAGEMENT AND SECURITY **9**

Resource Management: Inter Cloud Resource Management – Resource Provisioning and Methods – Security: Cloud Security Overview – Cloud Security Challenges – Virtual Machine Security – Application Security – Data Security.

CASE STUDIES **9**

Cloud Platforms: Google App Engine (GAE) – Amazon Web Services (AWS) – Microsoft Azure – OpenNebula – OpenStack.

d. Activities

- Quiz
- Crossword puzzle
- Chart Preparation

e. Learning Resources

Text Books

1. Buyya R, Broberg J and Goscinski A, *Cloud Computing: Principles and Paradigm*, First Edition, John Wiley & Sons, 2011.

2. Kai Hwang, Geoffrey C Fox and Jack G Dongarra, *Distributed and Cloud Computing, From Parallel Processing to the Internet of Things*, Morgan Kaufmann Publishers, 2012.

3. Rittinghouse, John W and James F Ransome, *Cloud Computing: Implementation, Management and Security*, CRC Press, 2017.

Course Code	Course Name	L	T	P	C
MCS107	**SOFTWARE ENGINEERING ESSENTIALS**	**3**	**0**	**0**	**3**

Category: Open Elective (Minor Degree)

a. Preamble

This course enables the students to understand the fundamental concepts of software process, requirements engineering, design and testing strategies. This course also explains about different Project Management techniques for software development.

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Explain the life cycle models for software development	K2
CO2	Model the static features using UML diagrams	K3
CO3	Apply the dynamic features using UML diagrams	K3
CO4	Identify the suitable management techniques	K2
CO5	Summarize the different testing methodologies	K2

c. Course Syllabus   **Total : 45 Periods**

SOFTWARE PROCESS   **9**

Introduction to Software Engineering, Software Process, Perspective and Specialized Process Models - Agile Methodology.

REQUIRMENTS ENGINEERING   **9**

Software Requirements - The software requirements Specification - Requirements engineering processes - Requirements elicitation and analysis - Requirements validation - Requirements management.

SOFTWARE DESIGN   **9**

Design Concepts – Architectural design: software architecture, architectural styles, architectural design – User interface design: the golden rules, user interface analysis and design steps – Design patterns.

SOFTWARE TESTING   **9**

Testing – Unit testing – Black box testing– White box testing – Integration and System testing– Regression testing – Debugging.

PROJECT MANAGEMENT

Software Project Management: Estimation – LOC, FP Based Estimation, COCOMO Model – Project Scheduling – Risk Management - Software Configuration Management.

d. Activities

Students shall be depicted the fundamental concepts of Software Engineering process.

e. Learning Resources

Text Book

1. Roger S Pressman, *Software Engineering: A practitioner's Approach*, 9th Edition, McGraw-Hill International Edition, 2019.

Reference Books

1. Rajib Mall, Fundamentals of Software Engineering, 5th Edition, PHI Learning Private Limited, 2018.

2. Ian Sommerville, Software Engineering, 10th Edition, Pearson Education Asia, 2017.

Course Code	Course Name	L	T	P	C
MCS108	**SOFTWARE PROJECT MANAGEMENT TECHNIQUES**	3	0	0	3

Category: Open Elective (Minor Degree)

a. Preamble

This course enables the students to understand software project management techniques and to manage the various phases involved in project management and people management. It enables the students to understand the benefits of activity planning and risk management principles. This course also enables the students to learn about the software quality management standards.

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Infer the activities in projects, planning and assessment.	K2
CO2	Construct network planning model to schedule the activities and overcome the anticipated risks.	K2
CO3	Outline the factors that influence the project management and control.	K2
CO4	Illustrate the strategy adapted in selecting right people for right job and organizing teams.	K2
CO5	Interpret the importance of software development standards to enhance the quality of projects.	K2

c. Course Syllabus   **Total : 45 Periods**

PROJECT EVALUATION AND PROJECT PLANNING   **9**

Project Definition - Activities Covered by Software Project Management - Overview of Stepwise Project Planning - Project Evaluation: Strategic Assessment, TechnicalAssessment - Risk Evaluation.

ACTIVITY PLANNING AND RISK MANAGEMENT   **9**

Objectives of Activity Planning - Project Schedules - Activities: Sequencing and Scheduling, Network Planning Models - Forward Pass & Backward Pass Techniques, Critical Path

Method - Risk Management: Identification, Assessment, Monitoring, PERT Technique, Monte Carlo Simulation.

PROJECT MANAGEMENT AND CONTROL   9

Framework for Management and Control: Collecting of Data, Project Termination - Visualizing Progress - Project Tracking - Managing Contracts: Types of Contract, Stages in Contract.

STAFFING   9

Managing People: Organizational Behavior, Best Methods of Staff Selection, Motivation - The Old man-Hackman Job Characteristics Model - Working in Teams - Decision Making - Team Structures: Virtual Teams - Communications Genres - Communication Plans.

SOFTWARE QUALITY   9

Software Quality in Project Planning: Importance of Software Quality, Defining Software Quality, ISO 9126 - Product and Process Metrics: Product versus Process Quality Management, Quality Management Systems - Process Capability Models.

d. Activities

- Quiz
- Team Activities
- Case Study

e. Learning Resources

Text Book

1. Bob Hughes, Mike Cotterell and Rajib Mall, Software Project Management, 6th Edition, Tata McGraw Hill, New Delhi, 2018.

Reference Books

1. Robert K Wysocki, Effective Software Project Management, Wiley Publication, 2011.
2. Gopalaswamy Ramesh, Managing Global Software Projects, McGraw Hill Education, 2013.