Savitribai Phule Pune University, Pune
Faculty of Science and Technology

Syllabus for

B.E (Electronics and Computer Engineering)

(Course 2019)

(w.e.f. June 2023)

SavitribaiPhulePune University

BE(Electronics&ComputerEngineering)2019Course

(With effect from Academic Year2023-24)

SemesterVII

CourseCode	CourseName	TeachingScheme(Hours/ week)			ExaminationSchemeandMarks						CreditScheme			
		Lecture	Practical	Tutorial	Mid-Sem	End-Sem	Termwork	Practical	Oral	Total	Lecture	Practical	Tutorial	Total
410341	Data Science and Visualization	03	-	-	30	70	-	-	-	100	03	-	-	03
410342	WebTechnology	03	-	-	30	70	-	-	-	100	03	-	-	03
410343	Internet of Things	03	-	-	30	70	-	-	-	100	03	-	-	03
410344	Elective-III	03	-	-	30	70	-	-	-	100	03	-	-	03
410345	Elective-IV	03	-	-	30	70	-	-	-	100	03	-	-	03
410346	Laboratory Practice I	-	04	-	-	-	25	50	-	75	-	02	-	02
410347	Laboratory Practice II	-	04	-	-	-	25	-	50	75	-	02	-	02
410348	Project Stage I	-	02	-	-	-	-	-	50	50	-	01	-	01
	Total	**15**	**10**	**-**	**150**	**350**	**50**	**50**	**100**	**700**	**15**	**05**	**-**	**20**
410349A	Mandatory Audit Course 7												**Grade**	
	TotalCredit										**15**	**05**	**-**	**20**

Elective-III

410344A: Big Data & Analytics
410344B: Mobile Application Development
410344C: Information and Cyber Security
410344D: Digital Image Processing

Elective-IV

410345A: Robotics & Automation
410345B: Human Computer Interface
410345C: Digital System Design
410345D: Augmented and Virtual Reality

MandatoryAudit Course 7(410349A)

- Botnet of Things
- Environmental issues and Disaster Management
- Emotional Intelligence
- Critical Thinking

LaboratoryPracticeI

Assignmentsfrom**Data Science and Visualization and Internet of Things**

LaboratoryPracticeII

Assignments from **Web Technology and Elective-III**

SavitribaiPhulePune University

BE(Electronics&ComputerEngineering)2019Course

(With effect from Academic Year2023-24)

SemesterVIII

CourseCode	CourseName	TeachingScheme(Hours/week)			ExaminationSchemeandMarks						CreditScheme			
		Lecture	Practical	Tutorial	Mid-Sem	End-Sem	Termwork	Practical	Oral	Total	Lecture	Practical	Tutorial	Total
410350	Artificial Intelligence and MachineLearning	03	-	-	30	70	-	-	-	100	03	-	-	03
410351	VLSI Design and Technology	03	-	-	30	70	-	-	-	100	03	-	-	03
410352	Elective-V	03	-	-	30	70	-	-	-	100	03	-	-	03
410353	Elective-VI	03	-	-	30	70	-	-	-	100	03	-	-	03
410354	Laboratory Practice III	-	04	-	-	-	25	50	-	75	-	02	-	02
410355	Laboratory Practice IV	-	02	-	-	-	25	-	50	75	-	02	-	02
410356	Project Stage II	-	08	-	-	-	100	-	50	150	-	04	-	04
	Total	**12**	**14**	**-**	**120**	**280**	**150**	**50**	**100**	**700**	**12**	**08**	**-**	**20**
410349B	Mandatory Audit Course 8													**Grade**
										TotalCredit	**12**	**08**	**--**	**20**

Elective-V

410352A: Cloud Computing
410352B: Embedded System and Real Time Operating Systems
410352C: Software Testing and Quality Assurance
410352D: Artificial Neural Network

Elective-VI

410353A: DataMiningand Warehousing
410353B: Electric Vehicle Technology
410353C: Software Defined Radio
410353D: Wireless Sensor Network
Open Elective*

MandatoryAuditCourse8(410349B)

- Business Intelligence
- Quantum Computing
- Cognitive Computing
- Technologies, Disruptions and EntrepreneurialOpportunities

***Any one subject from the list of Elective IV of computer/IT/E&TC Engg**

LaboratoryPracticeIII
AssignmentsfromArtificial Intelligence and MachineLearning andVLSIDesign and Technology

LaboratoryPracticeIV
AssignmentsfromElective-V

SEMESTER - VII

Savitribai Phule Pune University

BE Electronics and Computer Engineering (2019 Course)

410341:Data Science and Visualization

Teaching Scheme:	Credit:	Examination Scheme:
Theory: 03 hrs./week	03	In-Sem (Theory): 30 Marks End-Sem (Theory): 70 Marks

Prerequisite Courses, if any: Computer graphics, Database management system, Python

Companion Course, if any:

Course Objectives: To make the students understand

- **To learn** data collection and preprocessing techniques for data science
- **To Understand and practice** analytical methods for solving real life problems.
- **To study** data exploration techniques
- **To learn** different types of data and its visualization
- **To study** different data visualization techniques and tools
- **To map** element of visualization well to perceive information

Course Outcomes: After successfully completing the course, learner will be able to,

CO1: Apply data preprocessing methods on open access data and generate quality data for analysis
CO2: Apply and analyze classification and regression data analytical methods for real life Problems.
CO3: Implement analytical methods using Python/R
CO4: Apply different data visualization techniques to understand the data.
CO5: Analyze the data using suitable method; **visualize** using the open source tool.
CO6: Model Multi-dimensional data and visualize it using appropriate tool

Course Contents

Unit I	Introduction to Data Science	(07 Hrs.)

Introduction to Data Science: Definition, Data Science in various fields, Examples, Impact of Data Science, Data Analytics Life Cycle, Data Science Toolkit,

Understanding data: Introduction, Types of Data: Numeric, Categorical, Graphical, High Dimensional Data, Classification of digital Data: Structured, Semi-Structured and Unstructured, Quantitative vs. Categorical Data, Big Data vs. Little Data, Data science process, Role Data Scientist. **Sources of Data:** Time Series, Transactional Data, Biological Data, Spatial Data, Social Network Data, Data Evolution. Machine Learning Definition and Relation with Data Science

Mapping of Course Outcomes for Unit I	CO1: Apply data preprocessing methods on open access data and generate quality data for analysis

Unit II	Statistics and Probability basics for Data Analysis	(07 Hrs.)

Statistics: Introduction-Population and samples, Data Preparation, Need of Statistics in data science, Describing a Single Set of Data, Correlation, Simpson's Paradox, Correlation and Causation, Estimation: Sample and Estimated Mean, Variance and Standard Scores, Covariance, and Pearson's and Spearman's Rank Correlation, Measure of Dispersion: Range, Variation, mean deviation, standard deviation, Basics and need of hypothesis and hypothesis testing.

Probability : Dependence and Independence, Conditional Probability, Bayes's Theorem, Random Variables, Continuous Distributions, The Normal Distribution, The Central Limit Theorem

Mapping of Course Outcomes for Unit II	**CO2: Apply and analyze classification and regression data analytical methods for real life Problems.**	
Unit III	**Data Analysis in Depth**	**(07 Hrs.)**

Data Analysis Theory and Methods: Clustering –Overview, K-means- overview of method, determining number of clusters, Association Rules- Overview of method, Apriori algorithm, evaluation of association rules, Regression-Overview of linear regression method, model description. Classification- Overview, Naïve Bayes classifier

Mapping of Course Outcomes for Unit III	**CO3: Implement analytical methods using Python/R**	
Unit IV	**Advanced Data Analysis**	**(08 Hrs.)**

Decision Trees: What is a Decision Tree? Entropy, The Entropy of a Partition, Creating a Decision Tree, Random Forests.

Neural Networks: Perceptron's, Feed-Forward Neural Networks, Back propagation, Example: Defeating a CAPTCHA MapReduce: Why MapReduce? Examples like word count and matrix multiplication

Mapping of Course Outcomes for Unit IV	**CO4: Apply different data visualization techniques to understand the data.**	
Unit V	**Basics of Data Visualization**	**(07 Hrs.)**

Introduction to data visualization, challenges of data visualization, Definition of Dashboard, Dashboard type, Evolution of dashboard, dashboard design and principles, display media for dashboard. Types of Data visualization: Basic charts scatter plots, Bar plots, Histogram, box plot, Heat maps, advanced visualization Techniques like streamline and statistical measures, Plots, Graphs, Networks, Hierarchies, Reports, Different libraries in python for plotting graph.

Mapping of Course Outcomes for Unit V	**CO5: Analyze the data using suitable method; visualize using the open source tool.**	
Unit VI	**Data Visualization of Multidimensional data**	**(06 Hrs.)**

What is multidimensional data visualization? Need of data modeling, types of data modeling, advantages and disadvantages of data modeling, Data modeling process, what is Multi-Dimensional Data Model? advantages and disadvantages of Multi-Dimensional data modeling, multidimensional data visualization techniques: multiple line graphs, permutation matrix, survey plot, scatter plot matrix, parallel coordinates, tree map, Principal Components Analysis, Sammon's mapping, and the Self-Organizing Maps, clustering study of High dimensional data.

Mapping of Course Outcomes for Unit VI	CO6: Model Multi-dimensional data and visualize it using appropriate tool

Learning Resources

Text Books:

1. Jiawei Han, MichelineKamber, Jian Pei. Data Mining: Concepts and Techniques, 3rd Edition
2. Joel Grus, Data Science from Scratch, O'Reilly Media Inc., ISBN: 9781491901427
3. Colin ware, Information visualization perception for design, MK publication

Reference Books:

1. Big data black book, Dream tech publication
2. Getting Started with Business Analytics: Insightful Decision-Making , David Roi Hardoon, Galit Shmueli, CRC Press
3. Business Analytics , James R Evans, Pearson
4. Python Data science Handbook, *Jake VanderPlas, Orielly publication*
5. Data Science for Business: What You Need to Know about Data Mining and Data-Analytic Thinking, Vovost Foster, Fawcett Tom

e-Books:

handbook for visualizing : a handbook for data driven design by Andy krik:http://book.visualisingdata.com/

https://www.programmer-books.com/introducing-data-science-pdf/

An Introduction to Statistical Learning with Applications in R: http://faculty.marshall.usc.edu/gareth-james/ISL/

MOOC / NPTEL Courses:

- **https://nptel.ac.in/courses/106/106/106106179/**
- **https://nptel.ac.in/courses/106/106/106106212/**
- **https://nptel.ac.in/courses/106/105/106105174/**

Savitribai Phule Pune University

BE Electronics and Computer Engineering (2019 Course)

410342:Web Technology

Teaching Scheme:	Credit:	Examination Scheme:
Theory: 03 hrs./week	03	In-Sem (Theory): 30 Marks End-Sem (Theory): 70 Marks

Prerequisite Courses, if any: Computer Network , Database Management Systems

Companion Course, if any: Web Technology Lab

Course Objectives: To make the students understand

- To understand the principles and methodologies of web based applications development process
- To understand current client side and server side web technologies
- To understand current client side and server side frameworks
- To understand web services and content management

Course Outcomes: After successfully completing the course, learner will be able to,

CO1: Discuss the Internet & Web Technologies.
CO2: Discuss web development process and front end tools.
CO3: Apply JavaScript and jQuery to Validate the client side scripting.
CO4: Construct web based application using servlet and JSP for server side web technology.
CO5: Construct web based application using PHP for server side web technology.
CO6: Identify web services and content management for solving problem.

Course Contents

Unit I	Introduction to Internet and Web technology	(07 Hrs.)

Introduction to web technology, History of internet and www, Connecting to Internet, Introduction to Internet services and tools, Introduction to client-server computing. Introduction to WWW : Protocols and programs, HTTP Request message, HTTP response message, secure connections, Web Development Strategies , Web site planning and design issues , application and development tools, the web browser, web clients, web servers, choices, setting up UNIX and Linux web servers-, Logging users, dynamic IP, Study of web Application Servers Tomcat, Webshere, JBoss, GlassFish.

Mapping of Course Outcomes for Unit I	CO1: Discuss the Internet & Web Technologies.

Unit II	Web Development Process	(07 Hrs.)

Static & dynamic Web applications, HTML: structure of html document , HTML elements: headings, paragraphs, line break, colors & fonts, links, frames, lists, tables, images and forms, Difference between HTML and HTML5. CSS: Introduction to Style Sheet, Inserting CSS in an HTML page, CSS selectors, XML: Introduction to XML, XML key component, Transforming XML into XSLT, DTD: Schema,

elements, attributes, Introduction to JSON.		
Mapping of Course Outcomes for Unit II	**CO2: Discuss web development process and front end tools.**	
Unit III	**Client Side Technologies**	**(07 Hrs.)**
JavaScript: Overview of JavaScript, using JS in an HTML (Embedded, External), Data types, Control Structures, Arrays, Functions and Scopes, Objects in JS, DOM: DOM levels, DOM Objects and their properties and methods, Manipulating DOM, JQuery: Introduction to JQuery, Loading JQuery, Selecting elements, changing styles, creating elements, appending elements, removing elements, handling events.		
Mapping of Course Outcomes for Unit III	**CO3: Apply JavaScript and jQuery to Validate the client side scripting.**	
Unit IV	**Server Side Technologies**	**(07 Hrs.)**
Introduction to Server Side technology, Servlet: Introduction to Servlet, need and advantages, Servlet Lifecycle, Creating and testing of sample Servlet, session management. JSP: Introduction to JSP, advantages of JSP over Servlet, elements of JSP page: directives, comments, scripting elements, actions and templates, JDBC Connectivity with JSP. Struts: Overview, architecture, configuration, actions, interceptors, result types, validations, localization, exception handling, annotations.		
Mapping of Course Outcomes for Unit IV	**CO4: Construct web based application using servlet and JSP for server side web technology**	
Unit V	**Server Side Scripting Languages**	**(07 Hrs.)**
PHP: Introduction to PHP, Features, sample code, PHP script working, PHP syntax, conditions & Loops, Functions, String manipulation, Arrays & Functions, Form handling, Cookies & Sessions, using MySQL with PHP, WAP & WML, AJAX: Introduction, Working of AJAX, AJAX processing steps, coding AJAX script. Introduction to Angular JS &NodeJS.		
Mapping of Course Outcomes for Unit V	**CO5: Construct web based application using PHP for server side web technology.**	
Unit VI	**Web Services & Content Management System**	**(07 Hrs.)**
Web Services: Overview, types of WS, difference between SOAP and REST, EJB: types of EJB, benefits, Architecture, EJB technology, JNDI lookup, Introduction to Content Management System(CMS) ,Wordpress / Joomala, Advanced Technology: Bootstrap, JSF, Spring.		
Mapping of Course Outcomes for Unit VI	**CO6: Identify web services and content management for solving problem.**	
Learning Resources		
Text Books: 1. AchyutGodbole&AtulKahate, "Web Technologies: TCP/IP to Internet Application Architectures", McGraw Hill Education publications, ISBN, 007047298X, 9780070472983 2. Ralph Moseley & M. T. Savaliya, "Developing Web Applications", Wiley publications, ISBN 13 : 9788126538676		

Reference Books:

1. Adam Bretz& Colin J Ihrig, “Full Stack Javascript Development with MEAN”, SPD, ISBN-13: 978-0992461256
2. GiulioZambon, “ Beginning JSP, JSF and Tomcat”, Apress Publication, ISBN-10: 1430246235; ISBN-13: 978-1430246237
3. Jeremy McPeak& Paul Wilton,” Beginning JavaScript”, Wrox Publication, ISBN-13: 978-0470525937
4. Black Book, “Struts 2”, Dreamtech Press, ISBN 13,: 9788177228700
5. Black Book, “ JDBC 4.2, Servlet 3.1 & JSP 2.3”, Dreamtech Press, ISBN-13: 978-8177228700
6. Sandeep Panda, “Angular JS: Novice To Ninja”, SPD, First Edition 2014, ISBN-13: 978-0992279455 7. B. V. Kumar, S. Sangeetha, S. V. Subrahmanya,, “J2EE Architecture, an illustrative gateway to enterprise solutions”, Tata McGraw Hill Publishing Company. ISBN: 9780070621633
7. Brian Fling, “Mobile Design and Development”, O'REILLY, ISBN: 13:978-81-8404-817-9
8. Robin Nixon, “Learning PHP, Mysql and Javascript with JQuery, CSS & HTML5”, O'REILLY, ISBN: 13:978-93-5213-015-3
9. Allan Cole, Raeiva Jackson Armitage Brandon R. Jones Jeffrey Way, “Build Your Own Wicked Wordpress Themes”, SPD, ISBN: 978-93-5213-154-9
10. Ed Burnette, “Hello , Android Introducing Google' Mobile Development Platform”, SPD, ISBN: 13:978-93-5213-085-6

e-Books:

1. https://www.w3.org/html/
2. HTML, The Complete Reference http://www.htmlref.com/
3. http://w3schools.org/
4. http://php.net/
5. https://jquery.com/
6. https://developer.mozilla.org/en-US/docs/AJAX
7. http://www.tutorialspoint.com/css/

MOOC / NPTEL Courses:

1. http://www.nptelvideos.in/2012/11/internet-technologies.html
2. https://freevideolectures.com/course/2308/internet-technology/25videolectureby Prof. IndranilSengupta, IIT, Kharagpur
3. https://www.digimat.in/nptel/courses/video/106105191/L01.html
   http://www.nptelvideos.com/php/php_video_tutorials.php

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BE Electronics and Computer Engineering (2019 Course)

410343:Internet of Things

Teaching Scheme:	Credit:	Examination Scheme:
Theory: 03 hrs./week	03	In-Sem (Theory): 30 Marks End-Sem (Theory): 70 Marks

Prerequisite Courses, if any: Python

Companion Course, if any: IoT Lab.

Course Objectives: To make the students understand

- Introduction to different aspects of the IoT, including end devices, networks, programming, and security and privacy implications.
- Understand protocols used for IoT design solution.
- To understand concept of WSN and cloud computing
- To understand the Arduino and Raspberry Pi and their application n IoT
- To learn real world application scenarios of IoT along with its societal and economic impact using case studies

Course Outcomes: After successfully completing the course, learner will be able to,

CO1: Demonstrate and identify building blocks of Internet of things
CO2: Identify and analyze Internet of Things protocol and security for various applications.
CO3: Identify, analyze challenges of WSN and cloud computing in IoT
CO4: Develop interface of sensors and actuators with Arduino and Raspberry Pi and develop the program for the same
CO5: Demonstrate Big data architecture and identify components of Big Data Solution.
CO6: Apply the knowledge and skills to design and develop basic IoT applications on embedded platform.

Course Contents

Unit I	Fundamentals of Embedded system and IOT	(07 Hrs.)

Introduction to Embedded System, Characteristics, Introduction to Internet of Things, Emerging Trends, Economic Significance, Technical Building Blocks, Physical design of IoT, Logical design of IoT, Sensors and actuators, Introduction to IOT networking: Gateways and routing, IoT enabling technologies, IoT Issues and Challenges, Applications.

Mapping of Course Outcomes for Unit I	CO1: Demonstrate and identify building blocks of Internet of things

Unit II	IoT Protocols and Security	(07 Hrs.)

SCADA and RFID Protocols, IEEE 802.15.4, BACNet Protocol, Modbus, HART, Zigbee, MQTT, IoT

Security and privacy: Security Requirements, Challenges for Secure IoT, Key elements of IoT Security: Identity establishment, Access control, Data and message security, Security model for IoT.		
Mapping of Course Outcomes for Unit II	**CO2: Identify and analyze Internet of Things protocol and security for various applications.**	
Unit III	**WSN & Cloud Computing**	**(07 Hrs.)**
WSN: introduction to WSN technology, Basic components of WSN, Characteristic features of WSNs, challenges, Application of WSN in: smart homes, healthcare, intelligent transportation, agriculture, etc. **Cloud Computing:** Cloud architecture standards and interoperability, Business concerns in the cloud, characteristics, Cloud types; IaaS, PaaS, SaaS, Public cloud, Private cloud, Benefits and challenges of cloud computing, Development environments for service: Amazon, Azure, Thingspeak, Google App-cloud platform in industry (Features and services provided).		
Mapping of Course Outcomes for Unit III	**CO3: Identify, analyze challenges of WSN and cloud computing in IoT**	
Unit IV	**Implementation of IoT**	**(08 Hrs.)**
Implementation of IoT with Arduino: ATMega328p based Uno board: features pin diagram, functions of pins, structure of Arduino programs, Arduino open platform (IDE), introduction to Arduino I/O functions, sample GPIO for LED, LCD and PIR sensor program. Case study of implementation of distance measure Interfacing LED, LDR, LM35, DC motor, and Ultrasonic sensor with Arduino, Sending data to Cloud, analysis using any IoT platform. Introduction to Raspberry Pi, Raspberry Pi board overview, Programming environment, introduction to python programming, Simple assignments/programs using Raspberry Pi, interfacing of LED, ultrasonic sensor with Raspberry Pi, Sending data to cloud, analysis of data using any IoT platform.		
Mapping of Course Outcomes for Unit IV	**CO4: Develop interface of sensors and actuators with Arduino and Raspberry Pi and develop the program for the same**	
Unit V	**Big Data - Data Storage and Analytics**	**(07 Hrs.)**
What is Big Data (BD), Modern Corporate need of BD Strategy, Main components of Big Data Solution, Basic Architecture of BD Solution, Introduction to Hadoop, prototyping with any development board Data Analytics: Types of data analytics, Using Cloud Services to visualize live Data Streams, Data analytics using any one platform like Amazon, Azure, Thingspeak or any other open source platform.		
Mapping of Course Outcomes for Unit V	**CO5: Demonstrate Big data architecture and identify components of Big Data Solution.**	
Unit VI	**Technological Aggregation & Case Studies**	**(06 Hrs.)**
Modern trends in IOT: Wearable, industrial standards. Case studies using IoTs, connected use cases in Real-life and smart cities, Case studies: Greenhouse monitoring, smart health care monitoring, smart home automation, smart car parking, Smart Agriculture Monitoring, air pollution monitoring, smart industrial automation.		

Mapping of Course Outcomes for Unit VI	CO6: Apply the knowledge and skills to design and develop basic IoT applications on embedded platform.

Learning Resources

Text Books:

1. ArshdeepBahga, Vijay Madisetti,, Internet of Things, A hands-on approach, Universities Press
2. Honbo Zhou, The Internet of Things in the Cloud: A Middleware Perspective, CRC Press, 2012

Reference Books:

1. David Easley and Jon Kleinberg, Networks, Crowds, and Markets: Reasoning About a Highly Connected World, Cambridge University Press, 2010
2. Lyla B. Das, Embedded Systems: An Integrated Approach, Pearson
3. Dieter Uckelmann, Mark Harrison, Florian Michahelles, Architecting the Internet of Things, Springer, 2011
4. Olivier Hersent, Omar Elloumi and David Boswarthick, The Internet of Things: Applications to the Smart Grid and Building Automation, Wiley, 2012
5. Olivier Hersent, David Boswarthick, Omar Elloumi , The Internet of Things – Key applications and Protocols, Wiley, 2012
6. Barrie Sosinsky, Cloud Computing Bible, Wiley-India, 2010.
7. Adrian McEwen, Hakim Cassimally, Designing the Internet of Things, Wiley, 2014

MOOC / NPTEL Courses:

1. NPTEL Course Introduction To Internet Of ThingsBy Prof. SudipMisra IIT Kharagpur

Link of the Course:https://onlinecourses.nptel.ac.in/

Savitribai Phule Pune University

BE Electronics and Computer Engineering (2019 Course)

410344A:Big Data Analytics (Elective-III)

Teaching Scheme:	Credit:	Examination Scheme:
Theory: 03hrs./week	03	In-Sem (Theory): 30 Marks End-Sem (Theory): 70 Marks

Prerequisite Courses, if any:

1. Engineering and discrete mathematics.

2. Database Management Systems, Data warehousing and Data mining.

3. Programming skill.

Companion Course, if any:

1. Machine Learning
2. Advance Database Management

Course Objectives:

1. To introduce basic need of Big Data and Data science to handle huge amount of data.
2. To understand the basic mathematics behind the Big data.
3. To understand the different Big data processing technologies.
4. To understand and apply the Analytical concept of Big data using Python.
5. To visualize the Big Data using different tools.
6. To understand the application and impact of Big Data.

Course Outcomes: On completion of the course, students will be able to–

CO1: Understand Big Data primitives.

CO2: Learn and apply different mathematical models for Big Data.

CO3: Demonstrate Big Data learning skills by developing industry or research applications.

CO4: Analyze and apply each learning model comes from a different algorithmic approach and it will perform differently under different datasets.

CO5: Understand, apply and analyze needs, challenges and techniques for big data visualization.

CO6: Learn different programming platforms for big data analytics.

Course Contents

Unit I	Introduction: Data Science And Big Data	(06 Hrs.)

Introduction to Data science and Big Data, Defining Data science and Big Data, Big Data examples, **Data Explosion:** Data Volume, Data Variety, Data Velocity and Veracity. Big data infrastructure and challenges, **Big Data Processing Architectures:** Data Warehouse, Re-Engineering the Data Warehouse, shared everything and shared nothing architecture, Big data learning approaches. **Data Science** – The Big Picture: Relation between AI, Statistical Learning, Machine Learning , Data Mining and Big Data Analytics.

Mapping of Course Outcomes for Unit I	CO1: Understand Big Data primitives

Unit II	Mathematical Foundation of BigData	(07 Hrs.)
Probability: Random Variables and Joint Probability, Conditional Probability and concept of Markov chains, Tail bounds, Markov chains and random walks, Pair-wise independence and universal hashing, Approximate counting, Approximate median. **Data Streaming Models and Statistical Methods:** Flajolet Martin algorithm, Distance Sampling and Random Projections, Bloom filters, Mode, Variance, standard deviation, Correlation analysis and Analysis of Variance.		
Mapping of Course Outcomes for Unit II	**CO2: Learn and apply different mathematical models for Big Data.**	
Unit III	**Big Data Processing**	**(06 Hrs.)**
Big Data Analytics- Ecosystem and Technologies, Introduction to Google file system, Hadoop Architecture, **Hadoop Storage:** HDFS, Common Hadoop Shell commands, Anatomy of File Write and Read, NameNode, Secondary NameNode, and DataNode, Hadoop MapReduce paradigm, Map Reduce tasks, Job, Task trackers - Cluster Setup – SSH & Hadoop Configuration, Introduction to NOSQL, Textual ETL processing		
Mapping of Course Outcomes for Unit III	**CO3: Demonstrate Big Data learning skills by developing industry or research applications.**	
Unit IV	**Big Data Analytics**	**(06Hrs.)**
Big Data Analytics- Architecture and Life Cycle, Types of analysis, Analytical approaches, Data Analytics with Mathematical manipulations, Data Ingestion from different sources (CSV, JSON, html, Excel, mongoDB, mysql, sqlite), Data cleaning, Handling missing values, data imputation, Data transformation, Data Standardization, handling categorical data with 2 and more categories, statistical and graphical analysis methods, Hive Data Analytics.		
Mapping of Course Outcomes for Unit IV	**CO4: Analyze and apply each learning model comes from a different algorithmic approach and it will perform differently under different datasets**	
Unit V	**BIG DATA VISUALIZATION**	**(06Hrs.)**
Introduction to Data visualization, Challenges to Big data visualization, Conventional datavisualization tools, Techniques for visual data representations, Types of data visualization, Visualizing Big Data, Tools used in data visualization, Propriety Data Visualization tools, Open – source data visualization tools, **Case Study:** Analysis of a business problem of Zomato using visualization, Analytical techniques used in Big data visualization, Data Visualization using Tableau Introduction to: Candela, D3.js, Google Chart API		
Mapping of Course Outcomes for Unit V	**CO5: Understand, apply and analyze needs, challenges and techniques for big data visualization.**	
Unit VI	**Big Data Technologies Application and Impact**	**(06Hrs.)**
Social media analytics, Text mining, Mobile analytics, Data analytics life cycle of case studies, Organizational impact, understanding decision theory, creating big data strategy, big data value creation drivers, Michael Porter's valuation creation models, Big data user experience		

ramifications,Identifyingbig data use cases, Big Data Analytics Challenges and Research directions.	
Mapping of Course Outcomes for Unit VI	**CO6: Learn different programming platforms for big data analytics.**

Learning Resources

Text Books:

1. Krish Krishnan, Data warehousing in the age of Big Data, Elsevier, ISBN: 9780124058910, 1stEdition.
2. DT Editorial Services, Big Data, Black Book, DT Editorial Services, ISBN: 9789351197577, 2016Edition.

Reference Books:

1. Mitzenmacher and Upfal, Probability and Computing: Randomized Algorithms and ProbabilisticAnalysis, Cambridge University press, ISBN :521835402 .
2. Dana Ron, Algorithmic and Analysis Techniques in Property Testing, School of EE.
3. Graham Cormode, Minos Garofalakis, Peter J. Haas and Chris Jermaine, Synopses for Massive Data: Samples, Histograms, Wavelets, Sketches, Foundation and trends in databases, ISBN:10.1561/1900000004.
4. Alex Holmes, Hadoop in practice, Dreamtech press, ISBN:9781617292224.
5. AmbigaDhiraj, Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends forToday's Business, Wiely CIO Series.
6. ArvindSathi, Big Data Analytics: Disruptive Technologies for Changing the Game, IBMCorporation, ISBN:978-1-58347-380-1.
7. EMC Education Services, Data Science and Big Data Analytics- Discovering, analyzing Visualizingand Presenting Data.
8. Li Chen, Zhixun Su, Bo Jiang, Mathematical Problems in Data Science, Springer, ISBN :978-3- 319-25127-1.
9. Philip Kromer and Russell Jurney, Big Data for chips, O'Reilly, ISBN :9789352132447.
10. EMC Education services, Data Science and Big Data Analytics, EMC2 Wiley, ISBN :978812655653-
11. Mueller Massaron, Python for Data science, Wiley, ISBN :9788126557394.
12. EMC Education Services, Data Science and Big Data Analytics, Wiley India, ISBN:9788126556533
13. Benoy Antony, Konstantin Boudnik, Cheryl Adams,,ProfessionalHadoop, Wiley India,ISBN:9788126563029
14. Judith Hurwitz, Alan Nugent, Big Data For Dummies, Wiley India, ISBN : 9788126543281

MOOC / NPTEL Courses:

1. Zomato dataset Link: https://www.kaggle.com/shrutimehta/zomato-restaurants-data

2. Link for dataset: https://www.kaggle.com/tanmoyie/us-graduate-schools-admission-parameters

Savitribai Phule Pune University

BE Electronics and Computer Engineering (2019 Course)

410344B:Mobile Application Development(Elective-III)

Teaching Scheme:	Credit	Examination Scheme:
Theory: 03 hrs. / week	03	In-Sem (Theory): 30 Marks End Sem (Theory): 70 Marks

Prerequisite Courses, if any:

Companion Course, if any:

Course Objectives:

1. To facilitate students to understand android SDK
2. To help students to gain a basic understanding of Android application development
3. To inculcate working knowledge of Android Studio development too

Course Outcomes: On completion of the course, learner will be able to -

CO1: Identify various concepts of mobile programming that make it unique from programming for other platforms

CO2: Critique mobile applications on their design pros and cons

CO3: Utilize rapid prototyping techniques to design and develop sophisticated mobile interfaces

CO4: Program mobile applications for the Android operating system that use basic and advanced phone features

CO5: Deploy applications to the Android marketplace for distribution

CO6: Explain Security and Implement Application Deployment

Course Contents

Unit I	Introduction to Android	(06 Hrs.)

Introduction to Android: The Android Platform, Android SDK, Eclipse Installation, Android Installation, Building you First Android application, Understanding Anatomy of Android Application, Android Manifest file.

Mapping of Course Outcomes for Unit I	CO1: Identify various concepts of mobile programming that make it unique from programming for other platforms

Unit II	Android Application Design Essentials	(06 Hrs.)

Android Application Design Essentials: Anatomy of an Android applications, Android terminologies, Application Context, Activities, Services, Intents, Receiving and Broadcasting Intents, Android Manifest File and its common settings, Using Intent Filter, Permissions

Mapping of Course Outcomes for Unit II	CO2: Critique mobile applications on their design pros and cons

Unit III	Android User Interface Design Essentials	(06 Hrs.)

Android User Interface Design Essentials: User Interface Screen elements, Designing User Interfaces with

Layouts, Drawing and Working with Animation.		
Mapping of Course Outcomes for Unit III	**CO3: Utilize rapid prototyping techniques to design and develop sophisticated mobile interfaces**	
Unit IV	**Testing Android applications**	**(06 Hrs.)**
Testing Android applications, Publishing Android application, Using Android preferences, Managing Application resources in a hierarchy, working with different types of resources.		
Mapping of Course Outcomes for Unit IV	**CO4: Program mobile applications for the Android operating system that use basic and advanced phone features**	
Unit V	**Using Common Android APIs**	**(06 Hrs.)**
Using Common Android APIs: Using Android Data and Storage APIs, Managing data using SQLite, Sharing Data between Applications with Content Providers, Using Android Networking APIs, Using Android Web APIs, Using Android Telephony APIs, Deploying Android Application to the World.		
Mapping of Course Outcomes for Unit V	**CO5: Deploy applications to the Android marketplace for distribution**	
Unit VI	**Security and Application Deployment**	**(06 Hrs.)**
SMS telephony, Location Based Services, Creating the project, Getting the Maps API key, Displaying the map, Displaying the zoom control, Navigating to a specific location, Getting Location data, Monitoring location, Android Security Model		
Mapping of Course Outcomes for Unit VI	**CO6: Explain Security and Implement Application Deployment**	

Learning Resources

Text Books:

1. **Lauren Darcey and Shane Conder,** "Android Wireless Application Development", Pearson Education, 2nd ed. (2011)

Reference Books:

1. Reto Meier, "Professional Android 2 Application Development", Wiley India Pvt Ltd
2. Mark L Murphy, "Beginning Android", Wiley India Pvt Ltd
3. Android Application Development All in one for Dummies by Barry Burd, Edition: I

MOOC / NPTEL Courses:

1. https://onlinecourses.swayam2.ac.in/nou21_ge41/preview

Savitribai Phule Pune University

BE Electronics and Computer Engineering (2019 Course)

410344C:Information & Cyber Security(Elective-III)

Teaching Scheme:	Credit	Examination Scheme:
Theory: 03 hrs. / week	03	In Sem (Theory): 30 Marks End Sem (Theory): 70 Marks

Prerequisite Courses, if any:

Companion Course, if any:

Course Objectives: To make the students understand:

- To understand the basics of computer, network and information security.
- To study operating system security and malwares.
- To acquaint with security issues in internet protocols.
- To analyze the system for vulnerabilities.

Course Outcomes: At the end of the course, the student should be able to:

CO1: Use cryptographic techniques in secure application development.
CO2: Apply methods for authentication, access control, intrusion detection and prevention.
CO3: Apply the scientific method for security assessment.
CO4: Illustrate computer forensics knowledge.
CO5: Apply Key management factors for Secure Communication.
CO6: Apply knowledge to develop Prevention of software against virus.

Course Contents

UNIT I	Security Fundamentals	(06 Hrs.)

An Overview of Information Security: The Basic Components, Threats, Policy and Mechanism, Assumptions and Trust, Assurance, Operational Issues, Human Issues, Security nomenclature. Access Control Matrix, Security Policies: Confidentiality, Integrity, Availability Policies and Hybrid Policies, OS Security

Mapping of Course Outcomes for Unit I	CO1: Use cryptographic techniques in secure application development.

UNIT II	Modular Arithmetic and Cryptography Basics	(08 Hrs.)

Modular Arithmetic : Modular Arithmetic Notations, Modular Arithmetic Operations, Euclid's method of finding GCD, The extended Euclid's algorithm. Cryptography : Classical encryption techniques, Block and Chain ciphers, Data Encryption Standard, Advanced Encryption Standard, RC5

Mapping of Course Outcomes for Unit II	CO2: Apply methods for authentication, access control, intrusion detection and prevention.

UNIT III	Advanced Cryptography	(08 Hrs.)

Chinese Remainder Theorem and its implication in Cryptography, Diffie-Hellman key exchange algorithm, RSA algorithm, Elgamal Arithmetic, Elliptic Curve Cryptography, Message Digest and Cryptographic

Hash Functions, MD5 and SHA-1, Digital Signatures and Authentication.		
Mapping of Course Outcomes for Unit III	**CO2: To apply the scientific method for security assessment**	
UNIT IV	**Issues in Security Management and Cyber Laws**	**(08 Hrs.)**
Overview, Risk identification, Risk Assessment, Risk Control Strategies, Quantitative vs. Qualitative Risk Control Practices. Risk Management. Laws and Ethics in Information Security, Codes of Ethics, Protecting programs and data Cybercrime and Information security, Classification of Cybercrimes, The legal perspectives- Indian perspective, Global perspective, Categories of Cybercrime, Types of Attacks, a Social Engineering, Cyber stalking, Cloud Computing and Cybercrime.		
Mapping of Course Outcomes for Unit IV	**CO4: Illustrate computer forensics knowledge**	
UNIT V	**Key Management and Secure Communication**	**(08 Hrs.)**
Public Key Infrastructure (PKI), X.509 Certificate, Needham Schroeder algorithm and Kerberos. IP Security: IPv6 and IPSec, Web Security: SSL, HTTPS, Mail Security: PGP, S/MIME . Firewall : Different Types and Functionalities		
Mapping of Course Outcomes for Unit V	**CO5. Apply Key management factors for Secure Communication**	
UNIT VI	**Attacks, Malicious Logic and Countermeasures**	**(08 Hrs.)**
Phishing, Password Cracking, Key-loggers and Spywares, Types of Virus, Worms, DoS and DDoS, SQL injection, Buffer Overflow, Spyware, Adware and Ransomware. Antivirus and other security measures Intrusion Detection System: IDS fundamentals, Different types of IDS,Intrusion Prevention.		
Mapping of Course Outcomes for Unit VI	**CO6:Apply knowledge to develop Prevention of software against virus**	

Learning Resources

Text Book:

1. William Stallings, Computer Security: Principles and Practices, Pearson 6 Ed, ISBN 978-0-13-335469-0
2. Nina Godbole, SunitBelapure , Cyber Security- Understanding Cyber Crimes, Computer Forensics and Legal Perspectives, Wiely India Pvt.Ltd, ISBN- 978-81-265-2179-1

References:

1. BruiceSchneier , Applied Cryptography- Protocols, Algorithms and Source code in C, Algorithms, Wiely India Pvt Ltd, 2nd Edition, ISBN 978-81-265-1368-0.
2. CK Shyamalaet el., Cryptography and Security, Wiley India Pvt. Ltd, ISBN-978-81-265-2285-9.
3. BerouzForouzan, Cryptography and Network Security, TMH, 2 edition, ISBN -978-00-707-0208-0.
4. Mark Merkow, Information Security-Principles and Practices, Pearson Ed., ISBN- 978-81-317-1288-7.

Savitribai Phule Pune University

BE Electronics and Computer Engineering (2019 Course)

410344D:Digital Image Processing(Elective-III)

Teaching Scheme:	Credit:	Examination Scheme:
Theory: Hrs./week =3	03	In-Sem (Theory): 30 Marks End-Sem (Theory): 70 Marks

Prerequisite Courses, if any:

Companion Course, if any:

Course Objectives: To make the students understand

- To become familiar with digital image fundamentals
- To get exposed to simple image enhancement techniques in Spatial and Frequency domain.
- To learn concepts of degradation function and restoration techniques.
- To study the image segmentation and representation techniques.
- To become familiar with image compression and recognition methods

Course Outcomes: After successfully completing the course, learner will be able to,

CO1: Know and understand the basics and fundamentals of digital image processing, such as Digitization, sampling, quantization, and 2D-transforms.
CO2: Operate on images using the techniques of smoothing, sharpening and enhancement in spatial Domain.
CO3: Learn the basics of compression digital image and their different types.
CO4: Understand the restoration concepts and filtering techniques.
CO5: Learn the basics of segmentation &features extractiontechniques
CO6: Apply image processing algorithms for practical object recognition applications.

Course Contents

Unit I	Introduction to Digital Image Processing	(06Hrs.)

Introduction Fundamental Steps in Digital Image Processing, Components of an Image Processing System, Sampling and Quantization, Representing Digital Images (Data structure), Some Basic Relations, Human visual system, Sampling & quantization, Representing digital images, Spatial & gray-level resolution, Image file formats, Basic relationships between pixels, Distance Measures. Basic operations on images-image addition, subtraction, logical operations, scaling, translation, rotation. Image Histogram. Color fundamentals & models – RGB, HSI YIQ.

Mapping of Course Outcomes for Unit I	CO1: Know and understand the basics and fundamentals of digital image processing, such as digitization, sampling, quantization, and 2D-transforms.

Unit II	Image Enhancement in Spatial Domain	(07 Hrs.)

Some Basic Gray Level Transformations, Histogram Processing, Enhancement Using Arithmetic/Logic Operations.

Spatial domain enhancement: Point operations-Log transformation, Power-law transformation, Piecewise linear transformations, Histogram equalization. Filtering operations- Image smoothing, Image sharpening.

Frequency domain enhancement: 2D DFT, Smoothing and Sharpening in frequency domain. Homomorphic filtering. Restoration: Noise models, Restoration using inverse filtering and Wiener filtering.

Restoration: Noise models, Restoration using Inverse filtering and Wiener filtering

Mapping of Course Outcomes for Unit II	**CO2:Operate on images using the techniques of smoothing, sharpening and enhancement in spatial domain and frequency domain.**

Unit III	**Image Compression**	**(07 Hrs.)**

Types of redundancy, Fidelity criteria, Lossless compression – Runlength coding, Huffman coding, Bit-plane coding, Arithmetic coding. Introduction to DCT, Wavelet transform. Lossy compression – DCT based compression, Wavelet based compression. Image and Video Compression Standards – JPEG, MPEG.

Mapping of Course Outcomes for Unit III	**CO3:Learn the basics of compression digital image and their different types.**

Unit IV	**Image Segmentation and Morphological Operations**	**(07 Hrs.)**

Image Segmentation: Point Detections, Line detection, Edge Detection-First order derivative - Prewitt and Sobel. Second order derivative – LoG, DoG, Canny. Edge linking, Hough Transform, Thresholding - Global, Adaptive. Otsu's Method. Region Growing, Region Splitting and Merging. Morphological Operations: Dilation, Erosion, Opening, Closing, Hit-or-Miss transform, Boundary Detection, Thinning, Thickening, Skeleton.

Mapping of Course Outcomes for Unit IV	**CO4: Learn the basics of segmentation & features extraction techniques**

Unit V	**Image Restoration and Description**	**(06Hrs.)**

Image Restoration , degradation model, Properties, Noise models ,Mean Filters , Order Statistics , Adaptive filters , Band reject Filters, Band pass Filters ,Notch Filters , Optimum Notch Filtering, Inverse Filtering, Wiener filtering.

Representation, Chain codes, Polygonal approximation, Signatures. Boundary Descriptors, Shape numbers, Fourier Descriptors, Statistical moments. Regional Descriptors, Topological, Texture. Principal Components for Description.

Mapping of Course Outcomes for Unit V	**CO5: Understand the restoration concepts and filtering techniques.**

Unit VI	**Object Recognition and Applications**	**(06Hrs.)**

Feature extraction, Patterns and Pattern Classes, Representation of Pattern classes, Types of classification algorithms, Minimum distance classifier, Correlation based classifier, Bayes classifier. Applications: Biometric Authentication, Character Recognition, Content based Image Retrieval, Remote Sensing,

Medical application of Image processing	
Mapping of Course Outcomes for Unit VI	**CO6: Apply image processing algorithms for practical object recognition applications.**

Learning Resources

Text Books:

1. Rafael C. Gonzalez, Richard E. Woods, Digital Image Processing, Pearson, Third Edition, 2010.
2. Anil K. Jain, Fundamentals of Digital Image Processing, Pearson, 2002.

Reference Books:

1. Kenneth R. Castleman, Digital Image Processing, Pearson, 2006.

2. Rafael C. Gonzalez, Richard E. Woods, Steven Eddins, Digital Image Processing using MATLAB, Pearson Education, Inc., 2011.

3. D,E. Dudgeon and RM. Mersereau, Multidimensional Digital Signal Processing, Prentice Hall Professional Technical Reference, 1990.

4. William K. Pratt, Digital Image Processing, John Wiley, New York, 2002

5. Milan Sonka et al Image processing, analysis and machine vision, Brookes/Cole, Vikas Publishing House, 2nd edition, 1999.

6. B. Chanda& D. DuttaMajumder, " Digital Image Processing and Analysis", 2001.

7. Pratt W.K, "Digital Image Processing", Third Edition, John Wiley & Sons, 2001

MOOC / NPTEL Courses:

1. Digital Image Processing, IIT Kharagpur ,Prof. P.K. BiswasLink:
https://nptel.ac.in/courses/117105079

2. NPTEL Video Course : NOC:Digital Image ProcessingLink:
https://www.digimat.in/nptel/courses/video/117105135/L02.html

Savitribai Phule Pune University
BE Electronics & Computer Engineering (2019 Course)

410345A:Robotics and Automation(Elective-IV)

Teaching Scheme:	Credit	Examination Scheme:
Theory: 03 Hrs./Week	**03**	**In-Sem (Theory): 30** **End Sem (Theory): 70**

Prerequisite Courses, if any:

Companion Course, if any:

Course Objectives:

- To know basic parts of a typical industrial robot system with its anatomy with human body.
- To analyze mathematically kinematic and dynamic modeling of a typical robot manipulator.
- To select an appropriate type of robot with given specifications for different industrial applications.
- To know the basics of actuators, sensors and control of an industrial robot for different applications

Course Outcomes: On completion of the course, learner will be able to

CO1: Differentiate between types of robots based on configuration, method of control, types of drives, sensors used etc.

CO2: Choose a specific robot for specific application with given specifications.

CO3: Analyze the robot arm dynamics for calculation of torques and forces required for different joints of robots for control of robot arm.

CO4: Determine the D-H parameters for a robot configuration using concepts from robot arm kinematics which further leads to forward/inverse kinematics.

CO5: Calculate the Jacobian matrix for robot arm velocity and decide the singular positions.

CO6: Select a robotic system for given industrial application

Course Contents

Unit I	Introduction to Robotics	(06 Hrs.)

Robot components, Degrees of freedom, Robot joints, Robot reference frames, Robot specifications: repeatability, spatial resolution, compliance, load carrying capacity, speed of response, work volume, work envelope, reach etc., end effectors (Wrist), concept of: yaw, pitch and roll. Robot classification: according to Co-ordinate system: Cartesian, cylindrical, spherical, SCARA, Articulated, Control Method: Servo controlled & non-servo controlled, their comparative study, Form of motion: P-T-P (point to point), C-P (continuous path), pick and place etc. and their comparative study

Mapping of Course Outcomes for Unit I	CO1: Differentiate between types of robots based on configuration, method of control, types of drives, sensors used etc.

Unit II	Mathematical preliminaries	(06 Hrs.)

Homogeneous Coordinate, Translational Transformation, Rotational Transformation, coordinate reference frames, Effect of pre and post multiplication of transformation, Concept of Homogeneous transformation, Euler angles and singularities

Mapping of Course Outcomes for Unit II	**CO2: Choose a specific robot for specific application with given specifications.**	
Unit III	**Forward Kinematics:**	**(06 Hrs.)**
Denavit-Hartenberg (D-H) representation of kinematic chains. Rules for establishing link co-ordinate frames. Forward solution of robotic manipulator for SCARA Robot and PUMA Robot. Forward solution for simple robot systems.		
Mapping of Course Outcomes for Unit III	**CO3: Determine the D-H parameters for a robot configuration using concepts from robot arm kinematics which further leads to forward/inverse kinematics**	
Unit IV	**Inverse Kinematics and Robot Dynamics**	**(06 Hrs.)**
Inverse Kinematics: Concept of Inverse Kinematics, general properties of inverse solution such as existence and uniqueness of solution, inverse solution by direct approach, Geometric approach, inverse solution for simple SCARA Robots, numerical's for simple three axis robots based on direct approach. **Robot Dynamics:** Lagrange's Equation, Kinetic and potential energy Equations, Euler-Lagrange analysis for a single prismatic joint working against gravity and single revolute joint. Equation of motion.		
Mapping of Course Outcomes for Unit IV	**CO4:Determine the D-H parameters for a robot configuration using concepts from robot arm kinematics which further leads to forward/inverse kinematics**	
Unit V	**Differential motion and Control**	**(06 Hrs.)**
Manipulator Differential Motion: Concept of linear and angular velocity, Relationship between transformation matrix and angular velocity, manipulator Jacobian, Jacobian for prismatic and revolute joint, Jacobian Inverse, Singularities. **Control of Robot Arm:** Modeling of DC motor and load, closed loop control in position servo, the effect of friction and gravity, control of a robotic joint, position velocity and acceleration profiles for trapezoidal velocity profile. **Control of Robot manipulator**: joint position controls (JPC), resolved motion position controls (RMPC) & resolved motion rate control (RMRC).		
Mapping of Course Outcomes for Unit V	**CO5: Calculate the Jacobian matrix for robot arm velocity and decide the singular positions.**	
Unit VI	**Actuators and sensors**	**(06 Hrs.)**
Drive Technology: Hydraulic, Pneumatic, Electric (stepper motor, D.C. servo motor, BLDC Motors) in detail with selection criteria. Sensors in servo control system: Resolver, rotary shaft encoders, potentiometers, tacho-generators. **Industrial Applications of Robots:** Welding, Spray-painting, Grinding, Handling of rotary tools, Parts handling/transfer, Assembly operations, parts sorting, parts inspection, Potential applications in Nuclear and fossil fuel power plant etc. (Details for the above applications are selection criterion of robots, sensors used, selection of drives and actuators, methods of control, peripheral devices used etc).		
Mapping of Course Outcomes for Unit VI	**CO6: Select a robotic system for given industrial application**	

Note:

Industrial Visit:

At least one industrial visit should be arranged supporting the classroom teaching and student should submit a report on that industrial robot application including type of robot, method of control, type of application, sensor interface, method of programming etc.

Learning Resources

Text Books:

1. Mikell P. Groover, Mitchell Weiss, Roger N. Nagel, Nicholas G. Odrey, AshishDutta, "Industrial Robotics: Technology, Programming and Applications", Tata- McGraw Hill Education Private Limited, New Delhi, 2012.
2. Richard D. Klafter, Thomas A. Chemielewski, Michael Neign, "Robotic Engineering – An Integral Approach", Prentice Hall of India Pvt. Ltd., New Delhi. Eastern Economy Edition
3. Robert J. Schilling, "Fundamentals of Robotics: Analysis and Control", Prentice Hall of India, New Delhi

Reference Books:

1. K. S. Fu, R. C. Gonzalez, C. S. G. Lee, "Robotics: Control Sensing, Vision and Intelligence", International Edition, McGraw Hill Book Co.
2. John J. Craig, "Introduction to Robotics: Mechanics and Control", Pearson Education
3. R. K. Mittal, I. J. Nagrath, "Robotics and Control", Tata McGraw Hill Publishing Company Ltd., New Delhi
4. Saeed b. Niku, "Introduction to Robotics: Analysis, Control, Applications", Wiley Publication, 2011.

MOOC / NPTEL Courses:

2. NPTEL Course "*Title of the Course*", Name of the Faculty member, Name of the conducting Institute

Savitribai Phule Pune University
BE Electronics and Computer Engineering (2019 Course)

410345B:HumanComputer Interface (Elective-IV)

Teaching Scheme:	Credit	Examination Scheme:
Theory: 3 Hours/Week	**03**	**In-Sem (Theory):** 30 Marks **End Sem (Theory):** 70 Marks

Prerequisite Courses, if any:

1. Problem Solving and Object Oriented Technologies.

Companion Course, if any:

Course Objectives:

- To introduce to the field of human-computer-interaction study.
- To gain an understanding of the human part of human-computer-interactions.
- To learn to do design and evaluate effective human-computer-interactions.
- To study HCI models and theories.
- To understand HCI design processes.
- To apply HCI to real life use cases.

Course Outcomes: On completion of the course, learner will be able to

CO1: Explain importance of HCI study and principles of user-centered design (UCD) approach

CO2: Develop understanding of human factors in HCI design

CO3: Develop understanding of models, paradigms and context of interactions

CO4: Design effective user-interfaces following a structured and organized UCD process.

CO5: Evaluate usability of a user-interface design.

CO6: Apply cognitive models for predicting human-computer-interactions.

Course Contents

Unit I	Introduction	(06 Hours)
What is HCI?, Disciplines involved in HCI, Why HCI study is important? The psychology of everyday things, Principles of HCI, User-centered Design		
Mapping of Course Outcomes for Unit I	**CO1:Introduce to the field of human-computer-interaction study**	
Unit II	**Understanding the Human**	**(06 Hours)**
Input-output channels, Human memory, Thinking: Reasoning and Problem Solving, Human emotions, Individual differences, Psychology and Design		
Mapping of Course Outcomes for Unit II	**CO2: Develop understanding of human factors in HCI design.**	

Unit III	Understanding The Interaction	(06 Hours)
Models of interaction, Ergonomics, Interaction styles, WIMP Interface, Interactivity, Context of interaction, User experience, Paradigms of Interactions		
Mapping of Course Outcomes for Unit III	**CO3: To develop understanding of models, paradigms and context of interactions.**	
Unit IV	**HCI- Design Process**	**(06 Hours)**
What is interaction design?, The software design process, User focus, Scenarios, Navigation Design, Screen Design, Prototyping techniques, Wire-Framing, Understanding the UI Layer and Its Execution Framework, Model-View-Controller(MVC) Framework.		
Mapping of Course Outcomes for Unit IV	**CO4: Design effective user-interfaces following a structured and organized UCD process**	
Unit V	**HCI - Design Rules , Guidelines And Evaluation Techniques**	**(06 Hours)**
Principles that support usability, Design standards, Design Guidelines, Golden rules and heuristics, Using toolkits, User interface management system (UIMS), Goals of evaluation, Evaluation Criteria, Evaluation through expert analysis, Evaluation through user participation, Choosing an Evaluation Method		
Mapping of Course Outcomes for Unit V	**CO5: Evaluate usability of a user-interface design**	
Unit VI	**HCI Models And Theories**	**(06 Hours)**
Goal and task hierarchy model, Linguistic model, Physical and device models, Cognitive architectures, Hierarchical task analysis (HTA), Uses of task analysis, Diagrammatic dialog design notations, Computer mediated communication, Ubiquitous Computing, Finding things on web Future of HCI		
Mapping of Course Outcomes for Unit VI	**CO6: Apply cognitive models for predicting human-computer-interactions**	

Learning Resources

Text Books:

1. Alan Dix (2008). Human Computer Interaction. Pearson Education. ISBN 978-81-317-1703-5.
2. Gerard Jounghyun Kim (20 March 2015). Human–Computer Interaction: Fundamentals and Practice. CRC Press. ISBN 978-1-4822-3390-2.

Reference Books:

1. Shneiderman; Catherine Plaisant; Maxine Cohen; Steven Jacobs (29 August 2013). Designing the User Interface: Strategies for Effective Human-Computer Interaction. Pearson Education Limited. ISBN 978-1-292-03701-1.
2. Donald A. Norman (2013). The Design of Everyday Things Basic Books. ISBN 978-0-465-07299-6.
3. Jeff Johnson (17 December 2013). Designing with the Mind in Mind: Simple Guide to Understanding User Interface Design Guidelines. Elsevier. ISBN 978-0-12-411556-9.
4. Alan Cooper; Robert Reimann; David Cronin; Christopher Noessel (13 August 2014). About Face: The Essentials of Interaction Design. Wiley. ISBN 978-1-118-76658-3.
5. Alan Cooper (1 January 1999). The Inmates are running the Asylum, Sam's. ISBN 978-0-672-31649-4.
6. John M. Carroll (21 May 2003). HCI Models, Theories, and Frameworks: Toward a Multidisciplinary Science. Morgan Kaufmann. ISBN 978-0-08-049141-7.
7. Alan Cooper, Robert Reimann, David Cronin, Christopher Noessel, About Face: The Essentials of Interface Design,Wiley India, ISBN : 9788126559718,4th Edition.
8. Rogers, Sharp, Preece, Interaction Design: Beyond Human Computer Interaction, Wiley India, ISBN: 9788126544912,3rd Edition.
9. Wilbert O.Galitz, The Essential Guide to user Interface Design, Wiley India, ISBN: 9788126502806.

MOOC / NPTEL Courses/Web Links:

1. http://hcibib.org/
2. Andriod Design Guidelines - https://developer.android.com/guide/practices/ui_guidelines/index.html
3. iOS Human Interface Guidelines - https://developer.apple.com/ios/human-interfaceguidelines/overview/design-principles/
4. MacOS Human Interface Guidelines - https://developer.apple.com/library/content/documentation/UserExperience/Conceptual/OSXHIGui deli nes/

Savitribai Phule Pune University

BEElectronics & Computer Engineering (2019 Course)

410345C:Digital System Design (Elective-IV)

Teaching Scheme:	Credit	Examination Scheme:
Theory: 03 hrs. / week	03	In-Sem (Theory): 30 Marks End Sem (Theory): 70 Marks

Prerequisite Courses, if any: Digital Circuits

Course Objectives: To make the students understand

- Basic building blocks, logic gates, adders, multipliers, shifters and other digital devices.
- To apply logic minimization techniques, including Karnaugh Maps.
- Use of standard digital memory devices as components in complex subsystems.
- To learn techniques and tools for programmable logic design.

Course Outcomes: On completion of the course, learner will be able to –

CO1: **Understand** the basics of Hardware Description Languages, Program structure and basic Language elements of Verilog.

CO2: **Analyze**, **design** and **implement** combinational logic circuits.

CO3: **Analyze**, **design** and **implement** sequential circuits.

CO4: **Describe** the concepts of Datapath Controllers.

CO5: **Analyze** digital system design and arithmetic processor using PLD.

CO6: **Describe** the concepts of Postsynthesis Design of digital circuits.

Course Contents

Unit I	Introduction to Digital Design Methodology	(06 Hrs.)

Design Methodology, Overview of Digital Design with Verilog HDL, Hierarchical Modelling Concepts, Program Structure of Verilog, Logic System, Nets, Variables, and Constants, Vectors and Operators, Arrays, Logical Operators and Expressions, Gate-Level Modelling, Dataflow Modelling, Behavioral Modelling (Procedural Code).

Mapping of Course Outcomes for Unit I	CO1: Understand the basics of Hardware Description Languages, Program structure and basic language elements of Verilog.

Unit II	Combinational Logic Design	(06 Hrs.)

Review of Combinational and Sequential logic design, Structural models of combinational logic , Propagation delay , Behavioral Modeling, Boolean equation based behavioral models of combinational logic , Cyclic behavioral model of flip-flop and latches , A comparison of styles for behavioral modeling ,Design documentation with functions and tasks.

Mapping of Course Outcomes for Unit II	CO2: Analyze, design and implement combinational logic circuits.

Unit III	Sequential Logic Design	(06 Hrs.)

Synthesis of Combinational and Sequential logic , Introduction to synthesis ,Synthesis of combinational logic , Synthesis of sequential logic with latches, Synthesis of three-state devices and bus interfaces , Synthesis of sequential logic with flip-flops , Registered logic , Synthesis of gated clocks and clock enables , Anticipating the results of synthesis , Resets , Synthesis of loops , Design traps to avoid , Divide and Conquer: partitioning a design.

Mapping of Course Outcomes for Unit III	**CO3: Analyze, design and implement sequential circuits.**

Unit IV	**Design and Synthesis of Datapath Controllers**	**(06 Hrs.)**

Design and Synthesis of Datapath Controllers , Partitioned sequential machines , Design example: Binary counter , Design and synthesis of a RISC stored-program machine , Processor, ALU, Controller, Instruction Set, Controller Design and Program Execution , UART , Operation, Transmitter, Receiver.

Mapping of Course Outcomes for Unit IV	**CO4: Describe the concepts of Datapath Controllers.**

Unit V	**Programmable Logic Devices and Arithmetic Processors**	**(06 Hrs.)**

Programmable logic devices, Storage devices , Programmable Logic Array (PLA) , Programmable Array Logic (PAL) , Programmability of PLDs , Complex PLDs , Introduction to Altera and Xilinx FPGAs , Algorithms , Nested loop programs and data flow graphs , Design Example of Pipelined Adder, Pipelined FIR Filter , Circular buffers , FIFOs and Synchronization across clock domains , Functional units for addition, subtraction, multiplication and division , Multiplication of signed binary numbers and fractions.

Mapping of Course Outcomes for Unit V	**CO5: Analyse digital system design and arithmetic processor using PLD.**

Unit VI	**Post Synthesis Design Tasks**	**(06 Hrs.)**

Postsynthesis Design Validation , Postsynthesis Timing Verification, Elimination of ASIC Timing Violations , False Paths , Dynamically Sensitized Paths , System Tasks for Timing Verification , Fault Simulation and Testing , Fault Simulation ,JTAG Ports and Design for Testability.

Mapping of Course Outcomes for Unit VI	**CO6: Describe the concepts of Postsynthesis Design of digital circuits.**

Learning Resources

Text Books:

1. Michael D. Ciletti, "Advanced Digital Design with the VERILOG HDL, 2nd Edition, Pearson Education, 2010.
2. M. Morris Mano, “Digital Logic and Computer Design” 4the dition,Prentice Hall of India, 2013.

Reference Books:

1. Samir Palnitkar "Verilog HDL", 2nd Edition, Pearson Education, 2003.
2. Stephen Brown, "Fundamentals of Digital Logic with Verilog", McGraw-Hill-2007.
3. J. F. Wakerly, “Digital Design- Principles and Practices,” 3rd Edition, Pearson

MOOC / NPTEL Courses:

1. NPTEL Course on "**Digital System Design**"
https://nptel.ac.in/courses/108106177

Savitribai Phule Pune University

BE Electronics and Computer Engineering (2019 Course)

410345D:Augmented and Virtual Reality(Elective-IV)

Teaching Scheme:	Credit:	Examination Scheme:
Theory: 03hrs./week	03	In-Sem (Theory): 30 Marks End-Sem (Theory): 70 Marks

Prerequisite Courses, if any: Computer Graphics

Companion Course, if any:

Course Objectives: To make the students understand

- To understand fundamentals of augmented and virtual reality
- To describe various elements and components used in AR/VR Hardware and Software
- To understand the methods used for representing and rendering the virtual world
- To create Augmented Reality application that allows users to interact with the immersive 3D world.

Course Outcomes: After successfully completing the course, learner will be able to,

CO1: Understand the basics of Augmented and Virtual reality systems and list their applications
CO2: Describe interface to the Virtual World with the help of input and output devices
CO3: Explain representation and rendering system in the context of Virtual Reality
CO4: Analyze manipulation, navigation and interaction of elements in the virtual world
CO5: Summarize the basic concepts and hardware of Augmented Reality system
CO6: Create Mobile Augmented Reality using Augmented Reality techniques and software system.

Course Contents

Unit I	Introduction	(06 Hrs.)

Virtual Reality (VR): Introduction, Key Elements of VR, Experience, History, Applications.
Augmented Reality (AR): Introduction, History, Key Aspects, and Applications.

Mapping of Course Outcomes for Unit I	CO1: Understand the basics of Augmented and Virtual reality systems and list their applications.

Unit II	Interface To The Virtual World	(08 Hrs.)

Input: User Monitoring, Position Tracking, Body Tracking, Physical input Devices, Speech Recognition (Audio Input) and World Monitoring: Persistent Virtual Worlds, Bringing the Real World into the Virtual

World.

Output:

Visual Displays: Properties of Visual Displays, Monitor-based or Fishtank-VR, Projection-based VR, Head-based VR, See-through Head-based Displays, Handheld VR.

Aural Displays: Properties of Aural Displays, Head-based Aural Displays- Headphones, Stationary Aural Displays-Speakers.

Haptic Displays: Properties of Haptic Displays, Tactile Haptic Displays, End-effector Displays, Robotically Operated Shape Displays, Vestibular and Other Senses..

Mapping of Course Outcomes for Unit II	**CO2: Describe interface to the Virtual World with the help of input and output devices**

Unit III	**Representing And Rendering The Virtual World**	**(08 Hrs.)**

Representation of the Virtual World: Visual Representation in Virtual Reality, Aural Representation and Haptic Representation in Virtual Reality.

Rendering Systems:

Visual Rendering Systems: Visual Rendering Methods, Geometrically Based Rendering Systems, Non-geometric Rendering Systems, Rendering Complex Visual Scenes, Computer Graphics System Requirements.

Aural Rendering Systems: Visual Rendering Methods, Rendering Complex Sounds, Sound Generation Hardware, Internal Computer Representation.

Haptic Rendering Systems: Haptic Rendering Methods, Rendering Complex Haptic Scenes with Force Displays, Haptic Rendering Techniques.

Mapping of Course Outcomes for Unit III	**CO3: Explain representation and rendering system in the context of Virtual Reality**

Unit IV	**Interacting With The Virtual World And Virtual Reality Experience**	**(07 Hrs.)**

User Interface Metaphors, Manipulating a Virtual World, Properties of Manipulation, Manipulation Operations, Navigating in a Virtual World-Way finding and Travelling, Classes of Travel Methods Interacting with Others-Shared Experience, Collaborative Interaction, Interacting with the VR System, Immersion, Rules of the Virtual World: Physics, Substance of the Virtual World.

Mapping of Course Outcomes for Unit IV	**CO4: Analyze manipulation, navigation and interaction of elements in the virtual world**

Unit V	**Augmented Reality**	**(06 Hrs.)**

Concepts: Computer Graphics, Dimensionality, Depth Cues, Registration and Latency, Working of Augmented Reality, Augmented Reality Hardware (Sensors, Processors, Displays), Ingredients of an AR Experience.

Mapping of Course Outcomes for Unit V	**CO5: Summarize the basic concepts and hardware of Augmented Reality system**

Unit VI	**Augmented Reality Software And Mobile Augmented Reality**	**(07 Hrs.)**

Augmented Reality Systems, Software Components, Software Tools for Content Creation, Interaction in

Augmented Reality, **Augmented Reality Techniques:** Marker based and Marker less tracking, Mobile Augmented Reality.	
Mapping of Course Outcomes for Unit VI	**CO6: Create Mobile Augmented Reality using Augmented Reality techniques and software system.**

Learning Resources

Text Books:

1. William R Sherman and Alan B Craig, "Understanding Virtual Reality: Interface, Application and Design", (The Morgan Kaufmann Series in Computer Graphics)", Morgan Kaufmann Publishers, San Francisco, CA, 2002
2. Alan B Craig, "Understanding Augmented Reality, Concepts and Applications", Morgan Kaufmann Publishers, ISBN:978-0240824086

Reference Books:

1. Steven M. LaValle, "Virtual Reality", Cambridge University Press, 2016
2. Alan B Craig, William R Sherman and Jeffrey D Will, "Developing Virtual Reality Applications: Foundations of Effective Design", Morgan Kaufmann, 2009.
3. Schmalstieg / Hollerer, "Augmented Reality: Principles & Practice", Pearson Education India; First edition (12 October 2016),ISBN-10: 9332578494
4. SanniSiltanen, "Theory and applications of marker-based augmented reality", Julkaisija – Utgivare Publisher. 2012. ISBN 978-951-38-7449-0

MOOC Courses link:

- https://nptel.ac.in/courses/106/106/106106138/
- https://www.coursera.org/learn/introduction-virtual-reality
- https://www.coursera.org/learn/ar

e-Books :

- http://lavalle.pl/vr/book.html
- https://www.vttresearch.com/sites/default/files/pdf/science/2012/S3.pdf

Savitribai Phule Pune University

BE Electronics and Computer Engineering (2019 Course)

410346:Laboratory Practice I
(Data Science & Visualization and Internet of Things Lab)

Teaching Scheme:	Credit:	Examination Scheme:
Practical: 04 hrs. / week	02	Practical: 50 Marks Termwork: 25 Marks

Data Science & Visualization Lab

Prerequisite Courses, if any: Computer graphics, Database management system, Python

Companion Course, if any:

List of Laboratory Experiments:

(Perform Any 10 Experiments)

1. Data Manipulation in Python using Pandas.
2. Calculating Mean, Median, variance and plotting Correlation and Normal Distribution of a data using Python.
3. Importing and exporting CSV files using Pandas in Python and analyzing data (like shape, display of data in CSV file, checking missing value, and correlation) in CSV files.
4. Importing dataset (CSV file) and Python program to demonstrate the various plots using Matplotlib library on dataset.
5. Stock market analysis using Python Pandaswith suitable dataset.
6. Titanic Dataset Exploratory Data Analysis (EDA) using Seaborn.
7. Build training and testing dataset Titanic predict the probability of a survival of a person based on gender, age and passenger-class.
8. Implementation of Simple and Multiple Linear Regression With scikit-learn in Python
9. Implementation of K means Clustering in Python with suitable dataset
10. Implementation of decision tree classifier using python with suitable dataset.
11. Implementation of AND/NAND gate using feed forward Neural Network
12. Implementation of OR/NOR gate using feed forward Neural Network
13. Implementation of EX-OR gate using feed forward Neural Network

Savitribai Phule Pune University

BE Electronics and Computer Engineering (2019 Course)

Internet of Things Lab

List of Laboratory Experiments:

Group A (Perform Any 6)

1. Interfacing of LED with Arduino and program for blinking LED.
2. Interfacing touch sensor, LDR, Gas sensor with Arduino board and program for the same.
3. Interfacing of DC motor with Arduino and program for speed control of dc motor using PWM.
4. Interfacing of Interfacing of 16x2 LCD with Arduino board for display of message or information.
5. Interfacing temperature sensor LM35 with Arduino board and program to display temperature
6. Interfacing PIR sensor with Arduino board and program to turn on buzzer when motion detected
7. Interface RGB LED with Arduino board and program to display all possible color
8. Wireless communication between Arduino and PC using Bluetooth protocol.
9. Interfacing Wi-Fi module with Arduino.

Group B (Perform Any 4)

10. Study of different operating systems for Raspberry-Pi /Beagle board. Understanding the process of OS installation on Raspberry-Pi /Beagle board.
11. Study of Connectivity and configuration of Raspberry-Pi /Beagle board circuit with basic peripherals, LEDS. Understanding GPIO and its use in program.
12. Understanding the connectivity of Raspberry-Pi /Beagle board circuit with ultrasonic sensor. Write an application program of for measurement of distance.
13. Understanding the connectivity of Raspberry-Pi /Beagle board circuit with IR sensor. Write an application to detect obstacle and notify user using LEDs.
14. Understanding GPIO and its use in program. Interface buzzer using relay with Raspberry-Pi /Beagle board. Write an application to turn ON/OFF buzzer with certain delay.
15. Understanding and connectivity of Raspberry-Pi /Beagle board with a Zigbee module. Write a network application for communication between two devices using Zigbee.
16. Write a server application to be deployed on Raspberry-Pi /Beagle board. Write client applications to get services from the server application.

Group C (Any one Case study from the following)

17. Develop a Real time application like smart home with following requirements: When user enters into house the required appliances like fan, light should be switched ON. Appliances should also

get controlled remotely by a suitable web interface. The objective of this application is student should construct complete Smart application in group.

18. Develop a Real time application like a smart home with following requirements: If anyone comes at door the camera module automatically captures his image send it to the email account of user or send notification to the user. Door will open only after user's approval.

Savitribai Phule Pune University

BE Electronics and Computer Engineering (2019 Course)

410347:Laboratory Practice II
(Web Technology and Elective-III Lab)

Teaching Scheme:	Credit:	Examination Scheme:
Practical: 04 hrs. / week	02	Oral: 50 Marks Termwork: 25 Marks

Web Technology Lab

Prerequisite Courses, if any:

Companion Course, if any:

Course Objectives:

- To use current client side and server side web technologies
- To implement communication among the computing nodes using current client side and server side technologies
- To design and implement web services with content management

Course Outcomes:-

After successfully completing the course students will be able to,

CO1:- Understand the importance of website planning and website design issues.

CO2:- Design & Implement static web application using client side technologies.

CO3:- Develop dynamic web based application using suitable client side and server side web technologies

CO4:- Understand & Implement Web application using JavaScript & JQuery.

CO5:- Create three tier web based application

CO6:- Develop solution to complex problems using appropriate method, technologies, frameworks, web services and content management

Guidelines for Student Journal

The laboratory assignments are to be submitted by student in the form of journal. Journal consists of prologue, Certificate, table of contents, and **handwritten write-up** of each assignment (Title, Objectives, Problem Statement, Outcomes, software & Hardware requirements, Date of Completion, Assessment grade/marks and assessor's sign, Theory- Concept/technology/tool in brief, design, test cases, conclusion/analysis. **Program codes with sample output of all performed assignments are to be submitted as softcopy.**

Guidelines for Assessment

Continuous assessment of laboratory work is done based on overall performance and lab assignments performance of student. Each lab assignment assessment will assign grade/marks based on parameters with appropriate weightage. Suggested parameters for overall assessment as well as each lab assignment assessment include- timely completion, performance, innovation, efficient codes, punctuality and neatness.

Guidelines for Laboratory Conduction

The instructor is expected to frame the assignments by understanding the prerequisites, technological aspects, utility and recent trends related to the topic. The assignment framing policy need to address the average students and inclusive of an element to attract and promote the intelligent students. The instructor may set multiple sets of assignments and distribute among batches of students. It is appreciated if the assignments are based on real world problems/applications. Encourage students for appropriate use of Hungarian notation, proper indentation and comments. Use of open source software is to be encouraged. In addition to these, instructor may assign one real life application in the form of a mini-project based on the concepts learned. Instructor may also set one assignment or mini-project that is suitable to respective branch beyond the scope of syllabus.

List of Laboratory Assignments

1. Installation and Configuration of Web Application Servers Tomcat, Apache, WebSphere, JBoss, GlassFish.
2. Design and develop any suitable web application using HTML, CSS and XML in consultation of course instructor.
3. Design and implement a simple calculator using Java Script for operations like addition, multiplication, subtraction, division, square of number etc.
   a. Design calculator interface like text field for input and output, buttons for numbers and operators .
   b. Validate input values, Prompt/alerts for invalid values etc.
4. Implement the sample program demonstrating the use of Servlet with Mysql Connectivity. E.g. Create Employee Registration using Servlet.
5. Create Dynamic web application using JSP &MySql. E.g. :- Students Registration System
6. Design Dynamic we application using PHP &MysqlE.g:- Restaurant Management system
7. Design an application using Angular JS.e.g., Design registration (first name, last name, username, password) and login page using Angular JS.
8. Design, Develop and Deploy separate web application using EJB/CMS/JSF/Spring/Bootstrap.
9. **Mini Project**: Design and implement a dynamic web application for any business functionality by using web development technologies that you have learnt in the above given assignments.

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BE Electronics and Computer Engineering (2019 Course)

Big Data Analytics Lab: Elective-III Lab

Course Objectives:

1. To understand Big data primitives and fundamentals.
2. To understand the different Big data processing techniques.
3. To understand and apply the Analytical concept of Big data using Python.
4. To understand different data visualization techniques for Big Data.
5. To understand the application and impact of Big Data.
6. To understand emerging trends in Big data analytics.

Course Outcomes:On completion of the course, students will be able to–

CO1: Apply Big data primitives and fundamentals for application development.
CO2: Explore different Big data processing techniques with use cases.

CO3: Apply the Analytical concept of Big data using Python.
CO4: Visualize the Big Data using Tableau.
CO5: Design algorithms and techniques for Big data analytics.
CO6: Design and develop Big data analytic application for emerging trends.

List of Laboratory Assignments

Group A: Assignments based on the Hadoop

1. Single node/Multiple node Hadoop Installation.
2. Design a distributed application using MapReduce(Using Java) which processes a log file of a system. List out the users who have logged for maximum period on the system. Use simple log file from the Internet and process it using a pseudo distribution mode on Hadoop platform.
3. Write an application using HiveQL for flight information system which will include
   a. Creating, Dropping, and altering Database tables.
   b. Creating an external Hive table.
   c. Load table with data, insert new values and field in the table, Join tables with Hive
   d. Create index on Flight Information Table
   e. Find the average departure delay per day in 2008.

Group B: Assignments based on Data Analytics using Python

4. Perform the following operations using Python on the Facebook metrics data sets
   a. Create data subsets
   b. Merge Data
   c. Sort Data
   d. Transposing Data
   e. Shape and reshape Data
5. Perform the following operations using Python on the Air quality and Heart Diseases data sets
   a. Data cleaning
   b. Data integration
   c. Data transformation
   d. Error correcting
   e. Data model building
6. Integrate Python and Hadoop and perform the following operations on forest fire dataset
   a. Data analysis using the Map Reduce in PyHadoop
   b. Data mining in Hive
7. Visualize the data using Python libraries matplotlib, seaborn by plotting the graphs for assignment no. 2 and 3 (Group B)
8. Perform the following data visualization operations using Tableau on Adult and Iris datasets.
   a. 1D (Linear) Data visualization
   b. 2D (Planar) Data Visualization
   c. 3D (Volumetric) Data Visualization
   d. Temporal Data Visualization
   e. Multidimensional Data Visualization
   f. Tree/ Hierarchical Data visualization
   g. Network Data visualization

Group C: Model Implementation

Create a review scrapper for any ecommerce website to fetch real time comments, reviews, ratings,

comment tags, customer name using Python.
Develop a mini project in a group using different predictive models techniques to solve any real life problem. (Refer link dataset- https://www.kaggle.com/tanmoyie/us-graduate-schools- admission-parameters)

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BE Electronics and Computer Engineering (2019 Course)

Mobile Application Development Lab:Elective-III Lab

List of Laboratory Experiments

Group A: [Any 4 to be performed]

1. Compare various operating systems with Android OS.
2. Install or configure JAVA Development kit (JDK), android studio and android SDK.
3. Configure android Development Tools (ADT) plug-in and create android virtual device.
4. Develop a program to implement linear layout and absolute layout
5. Develop a program to implement Text View and Edit View

Group B: Compulsory

6. Develop a program to implement Autocomplete text view
7. Develop a program to implement Button, Image Button , Toggle Button
8. Develop a program to implement login window using UI controls
9. Develop a program to implement Checkbox

Group C: [Any 2 to be performed]

10. Develop a program to implement Date and Time Picker.
11. Develop a program to create an activity
12. Deploy a program to send SMS and receive SMS
13. Deploy Map based Application

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BE Electronics and Computer Engineering (2019 Course)

Information and Cyber Security Lab: Elective-III Lab

List of Laboratory Experiments(All Expt. are compulsory)

1. Setup a wired LAN using Layer 2 Switch. It includes preparation of cable, testing of cable using line tester, configuration machine using IP addresses, testing using PING utility and demonstrating the PING packets captured traces using Wireshark Packet Analyzer Tool
2. Demonstrate the different types of topologies and types of transmission media by using a packet tracer tool.
3. Setup a WAN which contains wired as well as wireless LAN by using a packet tracer tool. Demonstrate transfer of a packet from LAN 1 (wired LAN) to LAN2 (Wireless LAN).
4. Write a program for error detection and correction for 7/8 bits ASCII codes using Hamming Codes or CRC.

5. Write a program to simulate Go back N and Selective Repeat Modes of Sliding Window Protocol in Peer-to-Peer mode.
6. Implement a client and a server on different computers using python. Perform the communication between these two entities by using RSA cryptosystem.
7. Demonstrate how to provide secure data storage, secure data transmission & for creating digital signature.
8. Demonstrate intrusion detection system using any tool.
9. Implement a client and a server on different computers using python. Perform the encryption of message of sender between these two entities by using DES Algorithm and use Diffie Hellman method for exchange of keys.
10. Use the snort intrusion detection package to analyze traffic and create a signature to identify problem traffic.

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BE Electronics and Computer Engineering (2019 Course)

Digital Image Processing Lab: Elective-III Lab

Note: Experiments are to be performed using preferably open source software or MATLAB or C

List of Laboratory Experiments

Perform any 10 experiments:

1. Conversion of 24 bit color image to 8 bit, 4 bit image.
2. Perform Morphological operations –Erosion, Dilation, Opening, Closing
3. Apply image negation and power-law correction operations on image.
4. Study of statistical properties- Mean, Standard deviation, Variance & histogram plotting.
5. Enhance image using histogram equalization and stretching.
6. To perform image filtering in spatial domain.
7. To perform image filtering in frequency domain
8. Perform image smoothing and sharpening operations.
9. Detect image edges using Sobel, Prewitt and Roberts‟s operator.
10. Compress image using DCT / Wavelet transform.
11. Apply Global and adaptive thresholding to an image.
12. To perform image classification / recognition

Savitribai Phule Pune University

BE Electronics and Computer Engineering (2019 Course)

410348:Project Stage I

Teaching Scheme:	Credit:	Examination Scheme:
Practical: 02hrs. / week	01	Oral: 50 Marks

Prerequisite Courses, if any:

Companion Course, if any:

Course Objectives:

- To Apply the knowledge for solving realistic problem
- To develop problem solving ability
- To implement their ideas/real time industrial problem/ current applications from their engineering domain.
- To develop plans with help of team members to achieve the project's goals.
- To break work down into tasks and determine appropriate procedures.
- To estimate and cost the human and physical resources required, and make plans to obtain the necessary resources.
- To allocate roles with clear lines of responsibility and accountability and learn team work ethics.
- To apply communication skills to effectively promote ideas, goals or products.

Course Outcomes:On completion of the course, student will be able to–

- Solve real life problems by applying knowledge.
- Analyze alternative approaches, apply and use most appropriate one for feasible solution.
- To function effectively as a team to accomplish a desired goal.
- An understanding of professional, ethical, legal, security and social issues and responsibilities related to Information Technology Project.

Guidelines:

- Term work assessment is based on the project topic. It consists of Literature Survey and basic project work. The abstract of the project should be submitted before Term work assessment.
- The report consists of the Literature Survey, basic project work and the size of the report should be maximum of 30 to 35 pages.
- The assessment is based on Innovative Idea, Depth of understanding, Applications, Individual contributions, presentation, and the grade given by the internal guide based on the work carried out in a semester.
- A log book of Work carried out during the semester will be maintained with monthly review remarks by the guide and HoD.
- A certified copy of report is required to be presented to external examiner at the time of final examination.

1. **Group Size** The student will carry the project work individually or by a group of students. Optimum group size is in 3 students. However, if project complexity demands a maximum group size of 4 students, the committee should be convinced about such complexity and scope of the

work.

2. **Selection and approval of topic For Hardware Based Topics:** Topic should be related to real life application in the field of Electronics, for example:
   - Investigation of the latest development in a specific field of Electronics or Communication or Signal Processing
   - The investigation of practical problem in manufacture and / or testing of electronics or communication equipment
   - The Microprocessor / Microcontroller based applications project is preferable.
   - Software development project related to VHDL, Communication, Instrumentation, Signal Processing and Agriculture Engineering with the justification for techniques used / implemented is accepted.
   - Interdisciplinary projects should be encouraged. The examination will be conducted independently in respective departments.
3. **Selection and approval of topic for Software Based Topics:**

The majority of the students are expected to work on a real-life project preferably in some industry/ Research and Development Laboratories/Educational Institution/Software Company. Students are encouraged to work in the areas listed below. However, it is not mandatory for a student to work on a real-life project. The student can formulate a project problem with the help of her/his Guide and submit the project proposal of the same. Approval of the project proposal is mandatory. If approved, the student can commence working on it, and complete it. Use the latest versions of the software packages for the development of the project.

Software Based Project Areas:

- Database Management System
- Data Science and Data Analytics
- Any real-life project preferably in some industry/ Research and Development Laboratories/Educational Institution/Software Company
- C/C++, JAVA, Python etc. programming language based any new application
- Android Based application
- IoT Based application
- Artificial Intelligence Based application
- Machine Learning based application
- Deep Learning based application
- Areas are not limited to above

4. **Note:** The group should maintain a logbook of activities. It should have entries related to the work done, problems faced, solution evolved etc., duly signed by internal and external guides. Project report must be submitted in the prescribed format only. No variation in the format will be accepted. One guide will be assigned at the most 3 project groups.
5. Oral is based on presentation of the project work carried throughout the semester. Assessment is based on the project topic. It consists of Literature Survey and basic project work. The abstract of the project should be submitted before Term work assessment. The report consists of the Literature Survey, basic project work and the size of the report should be maximum of 40 pages. The examination is conducted by two examiners (internal and external) appointed by the university. The examiners appointed must have minimum 5 years of experience with UG qualification or 2 years with PG qualification.

6. The assessment is based on Innovative Idea, Depth of understanding, Applications, Individual contributions, presentation, and the grade given by the internal guide based on the work carried out in a semester.
7. A certified copy of report is required to be presented to external examiner at the time of final examination.

Savitribai Phule Pune University
BE Electronics and Computer Engineering (2019 Course)

410349A: MandatoryAudit Course 7: Botnet of Things

Course Objectives:

- To Understand the various IoT Protocols
- To Understand the IoT Reference Architecture and Real World Design Constraints
- To learn the concept of Botnet

Course Outcomes: On completion of the course, learner will be able to

- Implement security as a culture and show mistakes that make applications vulnerable to attacks.
- Understand various attacks like DoS, buffer overflow, web specific, database specific, web - spoofing attacks.
- Demonstrate skills needed to deal with common programming errors that lead to most security problems and to learn how to develop secure applications

Course Contents

1.Introduction

2.IRC-Based Bot Networks

3. Anatomy of a Botnet: The Gaobot Worm

4. IoT Sensors and Security : Sensors and actuators in IoT, Communication and networking in IoT, Real-time data collection in IoT, Data analytics in IoT , IoT applications and requirements, Security threats and techniques in IoT, Data trustworthiness and privacy in IoT, Balancing utility and other design goals in IoT , Future of Botnets in the Internet of Things, Thingbots, Elements of Typical IRC Bot Attack , Malicious use of Bots and Botnet

5. Service Layer Protocols and Security : Security: PHP Exploits, Cross-Site Scripting and Other Browser-Side Exploits, Bots and Botnets, Service Layer -oneM2M, ETSI M2M, OMA, BBF – Security in IoT Protocols –MAC 802.15.4 , 6LoWPAN, RPL, Application Layer Transport and Session layer protocols- transport Layer (TCP, MPTCP, UDP, DCCP, SCTP) - (TLS, DTLS) – Session Layer - HTTP, CoAP, XMPP, AMQP, MQTT

Savitribai Phule Pune University
BEElectronics and Computer Engineering (2019 Course)

410349A: MandatoryAudit Course 7: Environmental issues and Disaster Management

Course Objectives:

1.Study the various types of natural resources and problems due to over exploitation
2. Learn various factors which cause environmental pollution and their control measures
3. Study various hazards & disasters, their affects and mitigation measures.

Course Outcomes: On completion of the course, learner will be able to -
CO1: Understand the various types of natural resources and problems due to over exploitation
CO2: Understand various factors which cause environmental pollution and their control measures.
CO3: Understand various hazards & disasters, their affects and mitigation measures.

Course Contents

1. Environmental Pollution-

Environmental Pollution- Definition, Causes, effects and control of air pollution, water pollution, soil pollution, marine pollution, noise pollution, thermal pollution, nuclear hazards, human role in prevention of pollution, Solid waste management, Disaster management, floods, earthquake, cyclone and landslides.

2. Social issues and Environment

Unsustainable to sustainable development, Urban problems related to energy, Water conservation and watershed management, Resettlement and rehabitation, Ethics, Climate change, Global warming, Acid rain, Ozone layer depletion, Nuclear accidents, holocaust, Waste land reclamation, Consumerism and waste products, Environment protection act, Wildlife protection act, Forest conservation act, Environmental issues in legislation, population explosion and family welfare program, Environment and human health, HIV, Women and child welfare, Role of information technology in environment and human health.

3. Disaster Management

Introduction: Concepts and definitions: disaster, hazard, vulnerability, risk, capacity, impact, prevention, mitigation). Disasters classification; natural disasters (floods, draught, cyclones, volcanoes, earthquakes, tsunami, landslides, coastal erosion, soil erosion, forest fires etc.); manmade disasters (industrial pollution, artificial flooding in urban areas, nuclear radiation, chemical spills etc); hazard and vulnerability profile of India, mountain and coastal areas, ecological fragility

Learning Resources

Text Books:

1. http://ndma.gov.in/ (Home page of National Disaster Management Authority).
2. http://www.ndmindia.nic.in/ (National Disaster management in India, Ministry of Home Affairs).
3. PradeepSahni, 2004, Disaster Risk Reduction in South Asia, Prentice Hall.
4. Singh B.K., 2008, Handbook of Disaster Management: techniques & Guidelines, Rajat Publication.
5. Ghosh G.K., 2006, Disaster Management,APH Publishing Corporation.

Reference Books:

1.Agarwal, K.C., "Environmental Biology", Nidi Publication Ltd., Bikaner, 2001.
2. BharuchaErach, "Biodiversity of India," Mapin Publishing Pvt. Ltd., Ahmadabad, 2002.
3. Bukhootsow, B.," Energy Policy and Planning", Prentice Hall of India, New Delhi, 2003
4. Cunningham, W.P., " Environmental Encyclopedia", Jaico Publishing House, Mumbai, 2003.

Savitribai Phule Pune University

BEElectronics and Computer Engineering (2019 Course)

410349A:MandatoryAudit Course 7:Emotional Intelligence

Course Objectives:

- To develop an awareness of EI models
- To recognize the benefits of EI
- To understand how you use emotion to facilitate thought and behavior

- To know and utilize the difference between reaction and considered response

Course Outcomes:
On completion of the course, learner will be able to–

1. Expand your knowledge of emotional patterns in yourself and others
2. Discover how you can manage your emotions, and positively influence yourself and others
3. Build more effective relationships with people at work and at home
4. Positively influence and motivate colleagues, team members, managers
5. Increase the leadership effectiveness by creating an atmosphere that engages others

Course Contents

1. Introduction to Emotional Intelligence (EI) : Emotional Intelligence and various EI models, The EQ competencies of self-awareness, self-regulation, motivation, empathy, and interpersonal skills, Understand EQ and its importance in life and the workplace

2. Know and manage your emotions: emotions, The different levels of emotional awareness, Increase your emotional knowledge of yourself, Recognize „negative" and „positive" emotions. The relationship between emotions, thought and behavior, Discover the importance of values, The impact of not managing and processing „negative" emotions, Techniques to manage your emotions in challenging situations

3. Recognize emotions in others : The universality of emotional expression, Learn tools to enhance your ability to recognize and appropriately respond to others' emotions, Perceiving emotions accurately in others to build empathy

4. Relate to others: Applying EI in the workplace, the role of empathy and trust in relationships, Increase your ability to create effective working relationships with others (peers, subordinates, managers, clients, Find out how to deal with conflict, Tools to lead, motivate others and create a high performing team.

Learning Resources

Books:

1. Daniel Goleman," Emotional Intelligence – Why It Matters More Than IQ," , Bantam Books, ISBN-10: 055338371X13: 978-0553383713

2. Steven Stein , "The EQ Edge" , Jossey-Bass, ISBN : 978-0-470-68161-9

3. Drew Bird , "The Leader"s Guide to Emotional Intelligence" , ISBN: 9781535176002

Savitribai Phule Pune University

BEElectronics and Computer Engineering (2019 Course)

410349A: MandatoryAudit Course 7:Critical Thinking

Course Objective:

- To make students a better thinker, sharpen their mind, clarify thoughts, and help them to make smarter decisions (especially about career).
- To overcome shortcomings of fresh graduates that they are incapable of "independent decision making". We intend to overcome this shortcoming

Course Outcome:

- Students can expect to be smarter, stronger and more confident thinkers.
- Students can embark on a life-long journey of "self-directed learning".

1 An introduction to Critical Thinking

- What is Critical Thinking
  - o It"s role in problem solving
  - o The difference between a critical thinker and one who is not
- Barriers that prevent us from thinking critically

2 The importance of being logical

- Key concepts of "Thinking fast and slow" - Logical fallacies & Mistakes we make when do not think "statistically"

3 Patterns in deductive logic

- Hypothetical syllogism - Categorical syllogism(Set theory concepts)
- Argument by elimination, based on maths, based on definition
- Evaluating deductive arguments – validity & soundness

4 Argumentation – the foundation of critical thinking

- Recognizing arguments and their structural components & indicator words

Analysis of arguments

- Categorical logic - VENN Diagrams to test logical "validity"
- Propositional logic - Complex statements & arguments
- Truth Tables – to test validity of complex statements

5 Inductive reasoning

- The importance of inductive reasoning in hypothesis testing, analytics, belief systems, .
- Evaluating the strength of an inductive argument

6 Basic probability concepts

- Probability & frequency distributions
- Important parameters & measures
- Bayesian probability

SEMESTER – VIII

Savitribai Phule Pune University

BE Electronics and Computer Engineering (2019 Course)

410350:Artificial Intelligence and Machine Learning

Teaching Scheme:	Credit:	Examination Scheme:
Theory: 03 hrs./week	03	In-Sem (Theory): 30 Marks End-Sem (Theory): 70 Marks

Prerequisite Courses, if any: Python

Companion Course, if any:

Course Objectives: To make the students understand

- To understand the basic concept of AI, strength and weakness of problem solving and search
- To understand Problem Solving using various peculiar search strategies for AI
- To know about basic concepts of knowledge and reasoning.
- To know about basic concept of Machine learning and their types
- To understand classification &regression in Machine learning
- To know about basic concept of neural networks and model evaluation

Course Outcomes: After successfully completing the course, learner will be able to,

CO1:Evaluate Artificial Intelligence (AI) methods and describe their foundations.

CO2:Analyze and illustrate how search algorithms play vital role in problem solving, inference, perception, knowledge representation and learning.

CO3:Demonstrate knowledge of reasoning and knowledge representation for solving real world Problems.

CO4:Demonstratebasic knowledge of Machine learning for problem solving.

CO5:APPLY machine learning algorithms for classification and regression problems.

CO5:Summarize the neural networks working and its evaluation.

Course Contents

Unit I	Introduction to AI	(07 Hrs.)

Introduction to Artificial Intelligence, Foundation of Artificial Intelligence, Evolution of AI, Applications of AI, Classification of AI systems with respect to environment. Artificial Intelligence vs Machine learning, Statistical Analysis: Relationship between attributes: Covariance, Correlation Coefficient, Chi Square. Intelligent Agent: Concept of Rationality, nature of environment, structure of agents.

Mapping of Course Outcomes for Unit I	CO1: Evaluate Artificial Intelligence (AI) methods and describe their foundations.

Unit II	Problem Solving	(07 Hrs.)

Solving Problems by Searching, Problem-Solving Agents, Example Problems, Search Algorithms, Uninformed Search Strategies, Informed (Heuristic) Search Strategies, Heuristic Functions, Search in Complex Environments, Local Search and Optimization Problems.		
Mapping of Course Outcomes for Unit II	**CO2: Analyze and illustrate how search algorithms play vital role in problem solving, inference, perception, knowledge representation and learning**	
Unit III	**Knowledge and Reasoning**	**(07 Hrs.)**
Knowledge and Reasoning: Building a Knowledge Base: Propositional logic, first order Logic, situation calculus. Theorem Proving in First Order Logic, Planning, partial order planning. **Uncertain Knowledge and Reasoning:** Probabilities, Bayesian Networks. Probabilistic reasoning over time: time and uncertainty, hidden Markova models, Kalman filter, dynamic bayesian network, keeping track of many objects		
Mapping of Course Outcomes for Unit III	**CO3: Demonstrate knowledge of reasoning and knowledge representation for solving real world Problems**	
Unit IV	**Introduction to Machine Learning**	**(08 Hrs.)**
Introduction: What is Machine Learning, Examples of Machine Learning applications, Difference between Artificial intelligence and Machine learning, Difference Between Data Science and Machine Learning, Machine learning Life cycle Training versus Testing, Cross validation. **Types of Learning**: Supervised, Unsupervised and Semi-Supervised Learning, Difference between Supervised and Unsupervised Learning. **Dimensionality Reduction:** Introduction to Dimensionality Reduction, Subset Selection, Introduction to Principal Component Analysis.		
Mapping of Course Outcomes for Unit IV	**CO4: Demonstrate basic knowledge of Machine learning for problem solving**	
Unit V	**Classification & Regression**	**(07 Hrs.)**
Classification: Decision tree, Random forest, Naive Bayes, Support vector machine. **Regression:** Regression Analysis in Machine learning, Terminologies Related to the Regression Analysis,Types of Regression, Linear Regression, Logistic Regression, Support Vector Regression. **Regression trees**: Decision tree, random forest, K-Means, K-Nearest Neighbor (KNN). Applications of classification and regression algorithms.		
Mapping of Course Outcomes for Unit V	**CO5: APPLY machine learning algorithms for classification and regression problems.**	
Unit VI	**Neural Networks and Model Evaluation**	**(06 Hrs.)**
Biological Neurons and Model of Artificial Neuron. What is ANN? Neural Network Architectures: Single Layer Network, Multi-Layer Feed Forward Neural Networks, and Feedback Networks. Learning rules, Perceptron Model and Learning in Perceptron, Limitation of Learning in Perceptron. Learning rules and activation functions, Single layer and multilayer Perceptron , Model evaluation: understanding and interpretation of confusion matrix, Accuracy, Precision, Recall, Average Precision, mAP, True positive, false positive etc., Hyper parameter Tuning		

Mapping of Course Outcomes for Unit VI	CO6: Summarize the neural networks working and its evaluation

Learning Resources

Text Books:

1. Stuart Russell and Peter Norvig, "Artificial Intelligence: A Modern Approach", Third edition, Pearson, 2003, ISBN :10: 0136042597
2. Deepak Khemani, "A First Course in Artificial Intelligence", McGraw Hill Education(India), 2013, ISBN : 978-1-25-902998-1
3. Elaine Rich, Kevin Knight and Nair, "Artificial Intelligence", TMH, ISBN-978-0-07-008770-5
4. Giuseppe Bonaccorso, "Machine Learning Algorithms", Packt Publishing Limited, ISBN-10: 1785889621, ISBN-13: 978-1785889622
5. Josh Patterson, Adam Gibson, "Deep Learning: A Practitioners Approach", O"REILLY, SPD, ISBN: 978-93-5213-604-9, 2017 Edition 1st.

Reference Books:

1. Nilsson Nils J , "Artificial Intelligence: A new Synthesis", Morgan Kaufmann Publishers Inc. San Francisco, CA, ISBN: 978-1-55-860467-4
2. Patrick Henry Winston, "Artificial Intelligence", Addison-Wesley Publishing Company, ISBN: 0-201-53377-4
3. Dr. LavikaGoel, "Artificial Intelligence: Concepts and Applications", Wiley publication, ISBN: 9788126519934
4. Dr. Nilakshi Jain, "Artificial Intelligence, As per AICTE: Making a System Intelligent", Wiley publication, ISBN: 9788126579945
5. EthemAlpaydin, " Introduction to Machine Learning", PHI 2nd Edition-2013, ISBN 978-0-262-01243-0
6. Peter Flach, "Machine Learning: The Art and Science of Algorithms that Make Sense of Data", Cambridge University Press, Edition 2012, ISBN-10: 1107422221; ISBN-13: 978-1107422223
7. Tom Mitchell "Machine Learning" McGraw Hill Publication, ISBN : 0070428077 9780070428072
8. Nikhil Buduma, "Fundamentals of Deep Learning", O"REILLY publication, second edition 2017, ISBN: 1491925612
9. Giuseppe Bonaccorso, Machine Learning Algorithms, Published by Packt Publishing Ltd.

MOOC / NPTEL Courses:

- https://nptel.ac.in/courses/106/102/106102220/
- https://nptel.ac.in/courses/106/105/106105077/
- https://nptel.ac.in/courses/106/105/106105078/
- https://nptel.ac.in/courses/106/105/106105079/

Savitribai Phule Pune University

BE Electronics & Computer Engineering (2019 Course)

410351:VLSI Design and Technology

Teaching Scheme:	Credit	Examination Scheme:
Theory: 03 hrs. / week	03	In-Sem (Theory): 30 Marks End Sem (Theory): 70 Marks

Companion Course, if any: Laboratory Practice III

Course Objectives: To make the students understand

1. To understand CMOS technology and its application in VLSI Circuits.
2. To design digital circuits using HDL.
3. Describe the various types of semiconductor memories and issues involved in them.
4. To Understand the concept of Physical Design.
5. To implement digital circuits using FPGA.
6. To design using CAD tools.

Course Outcomes: On completion of the course, learner will be able to -

CO1: **Describe** the role of HDL in digital system design using VHDL and Verilog.

CO2: **Design** an Advanced digital circuit using HDL.

CO3: **Interpret** Memory elements along with timing considerations.

CO4: **Describe** the concepts of Physical design Process such as floor planning, placement and routing.

CO5: **Describe & Construct** digital circuit using PLD & FPGA and **Understand** the importance of testability in chip design.

CO6: **Describe** the Fundamentals of CMOS Technology in Digital Domain& **Design** CMOS circuits for specified applications.

Course Contents

Unit I	Introduction to HDL	(06 Hrs.)

Introduction: Why HDL? A Brief History of HDL, Features of VHDL, Structure of HDL, Module, Entity, Architecture, Operators, Data types, Types of Descriptions, Modelling styles in VHDL (Data-Flow, Behavioral and Structural), simulation and synthesis, Program Structure of Verilog, Logic System, Nets, Variables, and Constants, Vectors and Operators, Brief comparison of VHDL and Verilog.

Mapping of Course Outcomes for Unit I	CO1: Learn the role of HDL in digital system design using the latest tools like VHDL and Verilog.

Unit II	Digital Circuit Design and testing using HDL	(06 Hrs.)

Design of combinational circuits, Design of sequential circuits, asynchronousand synchronous design issues, state machine Modelling (Moore and Mealy machines),attributes, Generics, Basic test benches, Test bench structure, constrained random stimulusgeneration.

Mapping of Course Outcomes for Unit II	CO2: Design an Advanced digital circuits using HDL.

Unit III	CMOS Subsystem Design	(06 Hrs.)

Semiconductor memories, memory array organization, Random Access Memories (RAM),Static RAM (SRAM): 6T SRAM cell, sense amplifier, Dynamic RAM (DRAM), different DRAM cells, refresh circuits, timings.		
Mapping of Course Outcomes for Unit III	**CO3: Interpret Memory elements along with timing considerations.**	
Unit IV	**Floor Planning and Placement**	**(06 Hrs.)**
Floorplanning Methods: Chip-Level Physical Design, Block Placement and Channel Definition, Global Routing, Switchbox Routing, Interconnect Properties and Wiring Plans, Power Distribution, Clock Distribution, Packages, The I/O Architecture, Pad Design.		
Mapping of Course Outcomes for Unit IV	**CO4: Describe the concepts of Physical design Process such as floor-planning, placement and routing.**	
Unit V	**Design and Verification with PLD's**	**(06 Hrs.)**
Implementing Functions in FPGAs, Implementing Functions Using Shannon"sDecomposition, Carry Chains in FPGAs, Cascade Chains in FPGAs, Examples of LogicBlocks in Commercial FPGAs, Dedicated Memory in FPGAs, Dedicated Multipliers inFPGAs, JTAG, Boundary scan, TAP Controller.		
Mapping of Course Outcomes for Unit V	**CO5: Describe & Construct digital circuit using PLD & FPGA and Understand the importance of testability in chip design.**	
Unit VI	**Digital CMOS Circuits**	**(06 Hrs.)**
MOS Transistors Theory: Structure and Operation of n-channel enhancement MOSFET, MOSFET Current-Voltage Characteristics, CMOS Inverter- DC Characteristics, Voltage Transfer Characteristics, Noise Margin, Combinational MOS Logic Circuits: Pass Transistors/Transmission Gates; Designing with transmission gates. MOS Layers Stick/Layout Diagrams: Layout Design Rules, Issues of Scaling, Scaling factorfor device parameters.		
Mapping of Course Outcomes for Unit VI	**CO6: Describe the Fundamentals of CMOS Technology in Digital Domain & Design CMOS circuits for specified applications.**	

Learning Resources

Text Books:

1. Neil H. Weste and Kamran, Principles of CMOS VLSI Design, Pearson Publication.
2. Wayne wolf, Modern VLSI Design - IP Based Design, Pearson Education, 4th Edition.

Reference Books:

1. John F. Wakerly, Digital Design, Principles and Practices, Prentice Hall Publication.
2. Sung-Mo (Steve) Kang, Yusuf Leblebici, CMOS Digital Integrated Circuits, Tata McGraw Hill Publication.
3. Charles Roth, Digital System Design using VHDL, McGraw Hill Publication.
4. Douglas Perry, VHDL, McGraw Hill Publication.
5. Samir Palnitkar, Verilog HDL 2/e, Pearson Education.
6. R. Jacob Baker; Harry W.Li., David E. Boyce, CMOS Circuit Design, Layout and Simulation, IEEE

Press, Prentice Hall of India.
7. M.Ciletti, Advanced Digital Design with Verilog HDL,Second Edition Pearson Education.
8. NazeihM.Botros, "HDL Programming (VHDL and Verilog)", Dreamtech Press (Available through John Wiley – India and Thomson Learning), 2006 Edition.
9. Stephen Brown &ZvonkoVranesic, "Fundamentals of Digital Logic with Verilog Design", TMH.

MOOC / NPTEL Courses:

1.NPTEL Course on "NPTEL **course on Hardware Modeling using verilog**"
Link: https://nptel.ac.in/courses/106/105/106105165/

2. NPTEL Course on "**Advanced VLSI Design**"
Link: https://archive.nptel.ac.in/courses/117/101/117101004/

3. NPTEL Course on "**VLSI Physical Design**"
Link: https://nptel.ac.in/courses/106105161

Savitribai Phule Pune University

BE Electronics and Computer Engineering (2019 Course)

410352A:Cloud Computing (Elective-V)

Teaching Scheme:	Credit:	Examination Scheme:
Theory: 03hrs./week	03	In-Sem (Theory): 30 Marks End-Sem (Theory): 70 Marks

Prerequisite Courses, if any:

Companion Course, if any:

Course Objectives:

1. To provide students with the fundamentals and essentials of cloud computing
2. To learn basics of virtualization and its importance
3. To provide students a sound foundation of the cloud computing so that they are able to start using and adopting cloud computing services and tools in their real life scenarios
4. To enable students exploring some important cloud computing driven commercial systems and applications
5. To understand cloud storage technologies and relevant file systems
6. To be exposed to Ubiquitous Cloud and Internet of Things

Course Outcomes: On completion of the course, students will be able to–

CO1: Articulate the main concepts, key technologies and fundamentals of cloud computing.
CO2: Understand cloud enabling technologies and virtualization.
CO3: Analyze various cloud programming models and apply them to solve problems on the cloud.
CO4: Explain data storage and major security issues in the cloud.
CO5: Understand trends in ubiquitous cloud and internet of things.
CO6: Explore future trends of cloud computing.

Course Contents

Unit I	Fundamentals of Cloud Computing	(06Hrs.)

Origins and Influences, Basic Concepts and Terminology, Goals and Benefits, Risks and Challenges, Roles and Boundaries, Cloud Characteristics, Cloud Delivery Models, Cloud Deployment Models, Federated Cloud/Intercloud, Types of Clouds

Mapping of Course Outcomes for Unit I	CO1: Articulate the main concepts, key technologies and fundamentals of cloud computing.

Unit II	Cloud-Enabling Technology and Virtualization	(06 Hrs.)

Cloud-Enabling Technology: Broadband Networks and Internet Architecture, Data Center Technology, Virtualization Technology, Web Technology, Multitenant Technology, Service Technology.

Implementation Levels of Virtualization, Virtualization Structures/Tools and Mechanisms, Types of Hypervisors, Virtualization of CPU, Memory, and I/O Devices, Virtual Clusters and Resource Management, Virtualization for Data-Center Automation.		
Mapping of Course Outcomes for Unit II	**CO2: Understand cloud enabling technologies and virtualization**	
Unit III	**Common Standards and Cloud Platforms**	**(06 Hrs.)**
Common Standards: The Open Cloud Consortium, Open Virtualization Format, Standards for Application **Developers:** Browsers (Ajax), Data (XML, JSON), Solution Stacks (LAMP and LAPP), Syndication (Atom, Atom Publishing Protocol, and RSS), and Standards for Security. **Amazon web services:** Compute services Storage Services Communication Services Additional services **Google AppEngine:** Architecture and core concepts, Application life cycle, Cost model **Microsoft Azure:** Azure core concepts, SQL Azure, Windows Azure platform appliance		
Mapping of Course Outcomes for Unit III	**CO3: Analyze various cloud programming models and apply them to solve problems on the cloud.**	
Unit IV	**Data Storage and Security in Cloud**	**(06Hrs.)**
Cloud file systems: GFS and HDFS, BigTable, HBase and Dynamo Cloud data stores: Datastore and Simple DB GautamShrauf, Cloud Storage-Overview, Cloud Storage Providers. Securing the Cloud- General Security Advantages of Cloud-Based Solutions, Introducing Business Continuity and Disaster Recovery. Disaster Recovery- Understanding the Threats.		
Mapping of Course Outcomes for Unit IV	**CO4: Explain data storage and major security issues in the cloud.**	
Unit V	**Ubiquitous Clouds and Internet Of Things**	**(06Hrs.)**
Cloud Trends in Supporting Ubiquitous Computing, Performance of Distributed Systems and the Cloud, Enabling Technologies for the Internet of Things (RFID, Sensor Networks and ZigBee Technology, GPS), Innovative Applications of the Internet of Things (Smart Buildings and Smart Power Grid, Retailing and Supply-Chain Management, Cyber-Physical System), Online Social and Professional Networking.		
Mapping of Course Outcomes for Unit V	**CO5: Understand trends in ubiquitous cloud and internet of things.**	
Unit VI	**Future of Cloud Computing**	**(06Hrs.)**
How the Cloud Will Change Operating Systems, Location-Aware Applications, Intelligent Fabrics, Paints, and More, The Future of Cloud TV, Future of Cloud-Based Smart Devices, Faster Time to Market for Software Applications, Home-Based Cloud Computing, Mobile Cloud, Autonomic Cloud Engine, Multimedia Cloud, Energy Aware Cloud Computing, Jungle Computing. **Docker at a Glance:** Process Simplification, Broad Support and Adoption, Architecture, Getting the Most from Docker, The Docker Workflow		
Mapping of Course Outcomes for Unit VI	**CO6: Explore future trends of cloud computing.**	

Learning Resources

Text Books:

1. Thomas Erl, ZaighamMahmood and Ricardo Puttini, Cloud Computing: Concepts, Technology & Architecture, Pearson, ISBN :978 9332535923, 9332535922, 1 st Edition
2. Anthony T. Velte Toby J. Velte, Robert Elsenpeter, "Cloud Computing: A Practical Approach",**2010,** The McGraw-Hill.

Reference Books:

1. RajkumarBuyya, Christian Vecchiola, S. ThamaraiSelvi, Mastering Cloud Computing: Foundations and Applications Programming, McGraw Hill, ISBN: 978 1259029950, 1259029956.
2. GautamShrof, "ENTERPRISE CLOUD COMPUTING Technology Architecture, Applications, Cambridge University Press, ISBN: 9780511778476
3. Srinivasan, J. Suresh, Cloud Computing: A practical approach for learning and implementation, Pearson, ISBN :9788131776513.
4. Jack J. Dongarra, Kai Hwang, Geoffrey C. Fox, Distributed and Cloud Computing: From Parallel Processing to the Internet of Things, Elsevier, ISBN :9789381269237, 9381269238, 1st Edition.
5. Brian J.S. Chee and Curtis Franklin, Jr., Cloud Computing: Technologies and Strategies of the Ubiquitous Data Center, CRC Press, ISBN :9781439806128.
6. Kris Jamsa, Cloud Computing: Saas, Paas, Iaas, Virtualization, Business Models, Mobile, Security, and More, Jones and Bartlett, ISBN :9789380853772.
7. John W. Ritting house, James F. Ransome, Cloud Computing Implementation, Management, and Security, CRC Press, ISBN : 978 1439806807, 1439806802.
8. Karl Matthias, Sean P. Kane, Docker: Up and Running, OReilly, ISBN:9781491917572,1491917571.
9. Barrie Sosinsky, Cloud Computing Bible, Wiley, ISBN: 978 8126529803.
10. Ronald L. Krutz and Russell D. Vines, Cloud Security: A Comprehensive guide to Secure Cloud Computing, Wiley, ISBN: 9788126528097.
11. Scott Adkins, John Belamaric, Vincent Giersch, Denys Makogon, Jason E. Robinson, OpenStack:Cloud Application Development, Wrox, ISBN :9781119194316.
12. KailashJayaswal, JagannathKallakurchi, Donald J. Houde, Cloud Computing Black Book ,Wiley Dreamtech,ISBN:9789351194187

MOOC / NPTEL Courses:

Prof. SoumyaKantiGhosh IIT Kharagpur. Link of NPTEL

https://archive.nptel.ac.in/courses/106/105/106105167/

Savitribai Phule Pune University

BE Electronics and Computer Engineering (2019 Course)

410352B:Embedded System and Real Time Operating System: Elective-V

Teaching Scheme:	Credit:	Examination Scheme:
Theory: 03 hrs./week	03	In-Sem (Theory): 30 Marks End-Sem (Theory): 70 Marks

Prerequisite Courses, if any: Machine Learning, Python

Companion Course, if any:

Course Objectives: To make the students understand

- To understand the embedded system design issues.
- To learn real time operating system concepts.
- To understand the Embedded Linux environment
- To learn embedded software development and testing process.

Course Outcomes: After successfully completing the course, learner will be able to,

CO1: Get insight of design metrics of embedded systems and ARM Cortex.
CO2: Summarize Real time system concepts for Embedded system design.
CO3: Understand µCOS II RTOS services and programming.
CO4: Understand Embedded Linux Development Environment.
CO5: Understand Linux kernel construction and bootloader.
CO5: Get to know the hardware – software co-design issues and testing methodology for embedded system.

Course Contents

Unit I	Introduction to Embedded Systems	(06 Hrs.)

Introduction to Embedded Systems, Architecture, Classification and Characteristics of Embedded System, Design Metrics and optimization of various parameters of embedded system. ARM-CM3 Based Microcontroller LPC1768: Features, Architecture (Block Diagram & Its Description), System Control, Clock & Power Control, GPIO, Pin Connect Block.

Mapping of Course Outcomes for Unit I	CO1: Get insight of design metrics of embedded systems and ARM Cortex.

Unit II	Real Time Systems Concepts	(06 Hrs.)

Foreground/ Background systems, Critical section of code, Resource, Shared resource, multitasking, Task, Context switch, Kernel, Scheduler, Non-Preemptive Kernel, Preemptive Kernel, Reentrancy, Round robin scheduling, Task Priorities, Static & Dynamic Priority, Priority Inversion, Assigning task priorities, Mutual Exclusion, Deadlock, Clock Tick, Memory requirements, Advantages & disadvantages

of real time kernels.		
Mapping of Course Outcomes for Unit II	**CO2: Summarize Real time system concepts for Embedded system design.**	
Unit III	**µCOS II RTOS**	**(06 Hrs.)**
Task and Resource synchronization Features of, µCOS II, Kernel structure, µCOS II RTOS services: Task states, Task management services, Time management services, Task and Resource synchronization concept, Intertask Communication and Synchronization services (Semaphore, Mutex, Mailbox, Message queue, Pipe)		
Mapping of Course Outcomes for Unit III	**CO3: Understand µCOS II RTOS services and programming.**	
Unit IV	**Embedded Linux Development Environment**	**(07 Hrs.)**
Need of Linux, Embedded Linux Today, Advantages of Embedded Linux, Anatomy of Embedded System, Embedded Linux setup, Storage Considerations, Embedded Development Environment, Cross-Development Environment, Host System Requirements, and Hosting Target Boards, Development Tools.		
Mapping of Course Outcomes for Unit IV	**CO4: Understand Embedded Linux Development Environment**	
Unit V	**Linux Kernel Construction**	**(07 Hrs.)**
Linux Kernel Background, Linux Kernel Construction, Kernel Build System, Kernel Configuration, BIOS and Bootloader, Role of a Bootloader, Steps in Bootloader, Bootloader Challenges, Universal Bootloader: Das UBot, Porting U-Boot. Device Driver Concepts, Driver Methods, Module Utilities, Linux File System.		
Mapping of Course Outcomes for Unit V	**CO5: Understand Linux kernel construction and bootloader.**	
Unit VI	**Open Hardware/Software development systems and Case study**	**(08 Hrs.)**
Embedded Software development process and tools, Host and Target Machines, linking and Locating Software, Getting Embedded Software into the Target System, ATMega328p based Uno board: features pin diagram, functions of pins, structure of Arduino programs, Arduino open platform (IDE), introduction to Arduino I/O functions, sample GPIO for LED, LCD and PIR sensor program. Case study of implementation of distance measurement using ultrasonic and automatic car parking system.		
Mapping of Course Outcomes for Unit VI	**CO6: Analyze the applications of deep learning**	

Learning Resources

Text Books:

1. Text Books 1. Jean J.Labrosse, "MicroC OS II, The Real-Time Kernel", 2nd edition, CMP Books.
2. Christopher Hallinan, "Embedded Linux Primer -A Practical, Real-World Approach "2nd edition, Prentice Hall.

Reference Books:

1. Raj Kamal, “Embedded Systems – Architecture, Programming and Design" 2nd edition, McGraw Hill.
2. Frank Vahid and Tony Givargis, “ Embedded System Design – A Unified hardware/ Software introduction ” 3rd edition, Wiley.
3. https://www.nxp.com/docs/en/data-sheet/LPC1769_68_67_66_65_64_63.pdf
4. https://www.elprocus.com/atmega328-arduino-uno-board-working-and-its-applications/
5. https://www.tutorialspoint.com/arduino/index.htm

Savitribai Phule Pune University

BE Electronics and Computer Engineering (2019 Course)

410352C:Software Testing and Quality Assurance: Elective-V

Teaching Scheme: 03	Credit:	Examination Scheme:
Theory: 03hrs./week	03	In-Sem (Theory): 30 Marks End-Sem (Theory): 70 Marks

Prerequisite Courses, if any: Software Engineering and Project Management

Companion Course, if any:

Course Objectives: To make the students understand

- Introduce basic concepts of software testing
- Understand white box, block box, object oriented, web based and cloud testing
- Know in details automation testing and tools used for automation testing
- Understand the importance of software quality and assurance software systems development.

Course Outcomes: After successfully completing the course, learner will be able to,

CO1: Describe fundamental concepts in software testing such as manual testing, automation Testing and software quality assurance.

CO2: Design and develop project test plan, design test cases, test data, and conduct test operations

CO3: Explore the test automation concepts and tools and estimation of cost, schedule based on Standard metrics.

CO4: Apply recent automation tool for various software testing for testing software.

CO5: Apply different approaches of quality management, assurance, and quality standard to Software system.

CO6: Apply and analyze effectiveness Software Quality Tools

Course Contents

Unit I	Software Testing Basics	(06 Hrs.)

Testing as an engineering activity, Software Development Process , Role of process in software quality, Testing as a process, Basic definitions, Software testing principles, The tester's role in a software development organization, Origins of defects, Defect classes, The defect repository and test design, Defect examples, Developer / Tester support for developing a defect repository.

Mapping of Course Outcomes for Unit I	CO1: Describe fundamental concepts in software testing such asmanual testing, automation testing and software quality assurance.

Unit II	Testing Techniques And Levels Of Testing	(06 Hrs.)

Agile Methodology, Using White Box Approach to Test design - Static Testing Vs. Structural Testing, Code Functional Testing, Coverage and Control Flow Graphs, Using Black Box Approaches to Test Case Design, Random Testing, Gray Box testing, Requirements based testing, Decision tables, State-based testing, Cause-effect graphing, Error guessing, Compatibility testing, Levels of Testing - Unit Testing, Integration Testing, and Sanity Testing. System Integration Testing - Functional and Non Functional testing, Usability and Accessibility Testing, Configuration Testing, Compatibility Testing.

Mapping of Course Outcomes for Unit II	**CO2: Design and develop project test plan, design test cases, test data, and conduct test operations**

Unit III	**Software Automation Testing**	**(06 Hrs.)**

What is Test Automation, Terms used in automation, Skills needed for automation, What to automate, scope of automation, Design and Architecture of automation, Generic requirement forTest Tool, Process Model for Automation, Selecting Test Tool, Automation for XP/Agile model, Challenges in Automation, Data-driven Testing. Automation Tools like -Selenium, QTP, Selendroid, Appium, Sahi Pro.

Mapping of Course Outcomes for Unit III	**CO3: Explore the test automation concepts and tools and estimation of cost, schedule based on standard metrics.**

Unit IV	**Selenium Tool**	**(06 Hrs.)**

Introducing Selenium, Selenium Architecture, Brief History of The Selenium Project, Selenium's Tool Suite, SeleniumIDE, Selenium RC, Selenium Webdriver, Selenium Grid, Test Design Considerations

Mapping of Course Outcomes for Unit IV	**CO4: Apply recent automation tool for various software testing for testing software.**

Unit V	**Software Quality Management**	**(06 Hrs.)**

Software Quality, Software Quality Dilemma, Achieving Software Quality, Software Quality Assurance. Elements of SQA, SQA Tasks, Goals, and Metrics, Formal Approaches to SQA, Statistical Software Quality Assurance, Six Sigma for Software Engineering, ISO 9000 Quality Standards, SQA Plan.

Mapping of Course Outcomes for Unit V	**CO5: Apply different approaches of quality management, assurance, and quality standard to Software system.**

Unit VI	**Software Quality Tools**	**(06 Hrs.)**

Total Quality Management, Product Quality Metrics, In process Quality Metrics, Softwaremaintenance, Ishikawa's 7 basic tools, Checklists, Pareto diagrams, Histogram, Run Charts, Scatter diagrams, Control chart, Cause Effect diagram. Defect Removal Effectiveness and Process Maturity Level.

Mapping of Course Outcomes for Unit VI	**CO6: Apply and analyze effectiveness Software Quality Tools.**

Learning Resources

Text Books:

1. M G Limaye, "Software Testing Principles, Techniques and Tools", Tata McGraw Hill,

ISBN: 9780070139909 0070139903
2. SrinivasanDesikan, Gopalswamy Ramesh, “Software Testing Principles and Practices”, Pearson, ISBN-10: 817758121X.
3. Daniel Galin, Software Quality Assurance: From Theory to Implementation, Pearson Addison Wesley

Reference Books:

1. NareshChauhan, “Software Testing Principles and Practices ", OXFORD, ISBN-10: 0198061846. ISBN-13: 9780198061847
2. Stephen Kan, “Metrics and Models in Software Quality Engineering”, Pearson, ISBN-10:0133988082; ISBN-13: 978-0133988086
3. Aditya P. Mathur, Foundations of Software Testing, Pearson
4. Paul Ammann, Jeff Offutt, Introduction to Software Testing, Cambridge University Press

MOOC / NPTEL Courses: NPTEL Course on **“**Software Testing”
Link of the Course:https://nptel.ac.in/courses/106105150

Savitribai Phule Pune University

BE Electronics and Computer Engineering (2019 Course)

410352D:Artificial Neural Networks:Elective-V

Teaching Scheme:	Credit:	Examination Scheme:
Theory: 03 hrs./week	03	In-Sem (Theory): 30 Marks End-Sem (Theory): 70 Marks

Prerequisite Courses, if any: Machine Learning, Python.

Companion Course, if any:

Course Objectives: To make the students understand

- To understand neural networks working and its types
- To understand and acquire knowledge of artificial neural network and its different learning and computing mechanism
- To study how to model complex problems using deep learning network.
- To learn and design a solution by applying the principles of CNN and RNN to solve diversified complex problem

Course Outcomes: After successfully completing the course, learner will be able to,

CO1:Summarize the neural networks working and its types
CO2:Discuss deep learning along with the libraries used for different applications of DL
CO3:Design and implement feed forward neural network.
CO4: Apply CNN to solve diversified complex real world problems
CO5:Apply RNN to solve diversified complex real world problems
CO6:Analyze the applications of deep learning

Course Contents

Unit I	Neural Network	(08 Hrs.)

Biological Neurons and Model of Artificial Neuron. What is ANN? Neural Network Architectures: Single Layer Network, Multi-Layer Feed Forward Neural Networks, and Feedback Networks. Learning rules, Perceptron Model and Learning in Perceptron, Limitation of Learning in Perceptron. Learning rules and activation functions, Single layer and multilayer Perceptron , Self Organizing Map

Mapping of Course Outcomes for Unit I	CO1: Summarize the neural networks working and its types

Unit II	Introduction to Deep Learning	(07 Hrs.)

Introduction to Deep Learning, Difference between Artificial intelligence , Machine learning and Deep

learning, Supervised and Unsupervised learning, Architecture of Deep Neural Network, Tensor Flows and Keras, Deep Learning libraries, Building the Simplest Neural Network in Simple Python: AND gate, OR Gate, NOR gate, NAND, EX-OR etc. Deep Learning Tools: Caffe, Theano, Torch.		
Mapping of Course Outcomes for Unit II	**CO2: Discuss deep learning along with the libraries used for different applications of DL**	
Unit III	**Deep Feed forward Networks**	**(07 Hrs.)**
Artificial Neural Network, activation function, multi-layer neural network. Parameters Affecting Deep Learning: Normalization, Data Size, Regularization, Weight Initialization, Training Neural Network: Risk minimization, loss function, Backpropagation, regularization, model selection, and optimization, Back propagation networks, Architecture of Backpropagation (BP) Networks, loss function, hyper parameter and its tuning during training, Overfitting and Underfitting, Methods to avoid Overfitting and Underfitting, Vanishing Gradient Problem		
Mapping of Course Outcomes for Unit III	**CO3: Design and implement feed forward neural network.**	
Unit IV	**Convolution Neural Network (CNN)**	**(07 Hrs.)**
Introduction to Convolution Neural Network (CNN), Basic architecture of CNN, Components of CNN Convolution Layer -The Kernel (Filter), Stride and padding in CNN, Calculation of image size after application of filter, Pooling layer, Classification- Fully Connected Layer (FC Layer), Softmax Classification, various architectures of CNNs Designing a Convolutional Neural Network, Various Nonlinear activation function used in ANN like Sigmoid Function, Threshold Function, ReLU (rectified linear unit) Function, Hyperbolic Tangent Function,Applications of CNNs.		
Mapping of Course Outcomes for Unit IV	**CO4: Apply CNN to solve diversified complex real world problems**	
Unit V	**Recurrent Neural Network (RNN)**	**(07 Hrs.)**
Introduction to Recurrent Neural Network (RNN), Architecture of RNN, Why RNN? Types of recurrent neural networks, Forward Propagation and Back Propagation in a Recurrent Neural network, Training through RNN, different RNN architecture: Bidirectional recurrent neural networks (BRNN), Long Short Term Memory (LSTM) Advantages and disadvantage of Recurrent Neural Network, Two Issues of Standard RNNs, Applications of RNN		
Mapping of Course Outcomes for Unit V	**CO5: Apply RNN to solve diversified complex real world problems**	
Unit VI	**Application of Deep Learning**	**(07 Hrs.)**
Various application areas of deep learning, Large Scale Deep Learning, how to build and train of Convolutional Neural Network in Python, Speech Recognition using deep learning, Natural Language Processing using deep learning, Object/Image classification using deep learning, Deep Learning Applications in Agriculture, Handwritten Digit Recognition using CNN.		
Mapping of Course Outcomes for Unit VI	**CO6: Analyze the applications of deep learning**	

Learning Resources

Text Books:

1. Neural Networks, Fuzzy Logic and Genetic Algorithms: Synthesis & Applications, S.Rajasekaran, G. A. Vijayalakshami, PHI, 2007
2. Deep Learning By Ian Goodfellow, YoshuaBengio and Aaron Courville
3. Neural Networks and Learning Machines, 3d Edition Book by Simon S. Haykin

Reference Books:

1. Deep Learning with Python 1st Edition by Francois Chollet
2. Hands-On Machine Learning with Scikit-Learn and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems by GeronAurelien
3. Foundations of Neural Networks, Fuzzy Systems, and Knowldge Engineering, Nikola K. Kasabov, MIT Press, 1998
4. Grokking Deep Learning by Andrew W. Trask
5. https://towardsdatascience.com/convolutional-neural-networks-explained-9cc5188c4939
6. https://www.geeksforgeeks.org/introduction-to-recurrent-neural-network/
7. https://www.simplilearn.com/tutorials/deep-learning-tutorial/rnn
8. https://www.simplilearn.com/tutorials/deep-learning-tutorial

MOOC / NPTEL Courses:

1. NPTEL Course "*Neural Networks and Application*", Prof. SomnathSengupta, IIT Kharagpur

Link of the Course:https://nptel.ac.in/courses/117105084

Savitribai Phule Pune University

BE Electronics and Computer Engineering (2019 Course)

410353A:Data Mining and Warehousing-(Elective VI)

Teaching Scheme:	Credit:	Examination Scheme:
Theory: 03 hrs./week	03	**In-Sem (Theory): 30 Marks** **End-Sem (Theory): 70 Marks**

Prerequisite Courses, if any: Database Management Systems

Companion Course, if any:

Course Objectives: To make the students understand

- To understand the fundamentals of Data Mining
- To identify the appropriateness and need of mining the data
- To learn the preprocessing, mining and post processing of the data
- To understand various methods, techniques and algorithms in data mining

Course Outcomes: After successfully completing the course, learner will be able to,

CO1: Apply basic, intermediate and advanced techniques to mine the data

CO2: Understand warehousing architectures and tools for systematically organizing large database.

CO3: Optimize the mining process by choosing best data mining technique.

CO4: Characterize the kinds of patterns that can be discovered by association rule mining.

CO5: Identify interesting patterns from large amounts of data for predictions and single class classification.

CO6: Discover interesting patterns from large amounts of data for predictions and Multiclass Classification.

Course Contents

Unit I	Introduction to Data Mining	(06Hrs.)

Data Mining, Data Mining Task Primitives, Data: Data, Information and Knowledge; Attribute Types: Nominal, Binary, Ordinal and Numeric attributes, Discrete versus Continuous Attributes; Introduction to Data Preprocessing, Data Cleaning: Missing values, Noisy data; Data integration: Correlation analysis; transformation: Min-max normalization, z-score normalization and decimal scaling; data reduction: Data Cube Aggregation, Attribute Subset Selection, sampling; and Data Discretization: Binning, Histogram Analysis

Mapping of Course Outcomes for Unit I	CO1:Apply basic, intermediate and advanced techniques to mine the data.	
Unit II	**Data Warehouse**	**(06Hrs.)**

Data Warehouse, Operational Database Systems and Data Warehouses(OLTP Vs OLAP), A Multidimensional Data Model: Data Cubes, Stars, Snowflakes, and Fact Constellations Schemas; OLAP Operations in the Multidimensional Data Model, Concept Hierarchies, Data Warehouse Architecture, The Process of Data Warehouse Design, A three-tier data warehousing architecture, Types of OLAP Servers: ROLAP versus MOLAP versus HOLAP.		
Mapping of Course Outcomes for Unit II	**CO2: Understand warehousing architectures and tools for systematically organizing large database.**	
Unit III	**Measuring Data Similarity and Dissimilarity**	**(06Hrs.)**
Measuring Data Similarity and Dissimilarity, Proximity Measures for Nominal Attributes and Binary Attributes, interval scaled; Dissimilarity of Numeric Data: Minskowski Distance, Euclidean distance and Manhattan distance; Proximity Measures for Categorical, Ordinal Attributes, Ratio scaled variables; Dissimilarity for Attributes of Mixed Types, Cosine Similarity.		
Mapping of Course Outcomes for Unit III	**CO3:Optimize the mining process by choosing best data mining technique.**	
Unit IV	**Association Rules Mining**	**(06Hrs.)**
Market basket Analysis, Frequent item set, Closed item set, Association Rules, a-priori Algorithm, Generating Association Rules from Frequent Item sets, Improving the Efficiency of a-priori, Mining Frequent Item sets without Candidate Generation: FP Growth Algorithm; Mining Various Kinds of Association Rules: Mining multilevel association rules, constraint based association rule mining, Meta rule-Guided Mining of Association Rules.		
Mapping of Course Outcomes for Unit IV	**CO4:Characterize the kinds of patterns that can be discovered by association rule mining.**	
Unit V	**Classification**	**(06Hrs.)**
Introduction to: Classification and Regression for Predictive Analysis, Decision Tree Induction, Rule-Based Classification: using IF-THEN Rules for Classification, Rule Induction Using a Sequential Covering Algorithm. Bayesian Belief Networks, Training Bayesian Belief Networks, Classification Using Frequent Patterns, Associative Classification, Lazy Learners-k-Nearest-Neighbor Classifiers, Case-Based Reasoning.		
Mapping of Course Outcomes for Unit V	**CO5: Identify interesting patterns from large amounts of data for predictions and single class classification.**	
Unit VI	**Multiclass Classification**	**(06Hrs.)**
Multiclass Classification, Semi-Supervised Classification, Reinforcement learning, Systematic Learning, Wholistic learning and multi-perspective learning. Metrics for Evaluating Classifier Performance: Accuracy, Error Rate, precision, Recall, Sensitivity, Specificity; Evaluating the Accuracy of a Classifier: Holdout Method, Random Sub sampling and Cross-Validation.		
Mapping of Course Outcomes for Unit VI	**CO6: Discover interesting patterns from large amounts of data for predictions and Multiclass Classification.**	

Learning Resources

Text Books:

1. Han, JiaweiKamber, Micheline Pei and Jian, “Data Mining: Concepts and Techniques”, Elsevier Publishers, ISBN:9780123814791, 9780123814807.
2. ParagKulkarni, “Reinforcement and Systemic Machine Learning for Decision Making” by Wiley-IEEE Press, ISBN: 978-0-470-91999-6
3. Alex Berson and Stephen J. Smith “Data Warehousing, Data Mining & OLAP”, Tata McGraw – Hill Edition, Tenth Reprint 2007.

Reference Books:

1. Matthew A. Russell, "Mining the Social Web: Data Mining Facebook, Twitter, LinkedIn, Google+, GitHub, and More" , Shroff Publishers, 2nd Edition, ISBN: 9780596006068
2. MaksimTsvetovat, Alexander Kouznetsov, "Social Network Analysis for Startups: Finding connections on the social web", Shroff Publishers , ISBN: 10: 1449306462
3. G. K. Gupta “Introduction to Data Mining with Case Studies”, Easter Economy Edition, Prentice Hall of India, 2006.
4. Pang-Ning Tan, Michael Steinbach and Vipin Kumar “Introduction to Data Mining”, Pearson Education, 2007
5. K.P. Soman, ShyamDiwakar and V. Ajay “Insight into Data mining Theory and Practice”, Easter Economy Edition, Prentice Hall of India, 2006.

Savitribai Phule Pune University

BE Electronics and Computer Engineering (2019 Course)

410353B:Electric Vehicle Technology (Elective-VI)

Teaching Scheme:	Credit:	Examination Scheme:
Theory: 03 hrs./week	**03**	**In-Sem (Theory): 30 Marks** **End-Sem (Theory): 70 Marks**

Prerequisite Courses, if any: Power Electronics

Companion Course, if any:

Course Objectives: To make the students understand

- Understand about basics of electric vehicle
- Learn Electric/Electronic and Mechatronics Components of EV
- Understand about drives and control
- Select battery, battery indication system for EV applications
- Design battery charger for an EV

Course Outcomes: After successfully completing the course, learner will be able to,

CO1: Understand about basics of electric vehicle.
CO2: Describe Electric/Electronic and Mechatronics Components of EV.
CO3: Illustrate the Electric Drive Train System for EV.
CO4: Select battery, battery indication system and battery management system for EV applications.
CO5: Understand Electric Vehicle Architecture Design and Charging Infrastructure.
CO6: Illustrate the challenges in Electric Vehicle and solutions.

Course Contents

Unit I	Basics of Electric Vehicle	(06Hrs.)

Review of Conventional Internal Combustion Engine vehicles, History of EV, Block diagram and working Principle of EV, How Does an Electric Vehicle Work?, Types of Electric vehicles and Working Principles, Advantages of EV over other vehicles, Limitations of EV.Comparison of EV with Internal Combustion Engine vehicles, Challenges in EV design, EV Terminology.

Mapping of Course Outcomes for Unit I	CO1:Understand about basics of electric vehicle.

Unit II	Components and Functions of Electric Vehicle	(06Hrs.)

Major Electric/Electronic Components of EV and their function,Power inverters, Control Unit, DC to DC

convertor,Drive train, Battery management, Major Mechanical (Mechatronics) Components and their function, Parameters consideration before design EV, Selection criteria of the component while designing the EV, Standards required as per AIS norms.		
Mapping of Course Outcomes for Unit II	**CO2: Describe Electric/Electronic and Mechatronics Components of EV**	
Unit III	**Electric Drive Train System**	**(06Hrs.)**
Energy consumption Concept of Drive Trains, Architecture of Electric Drive Trains, Basic concept of electric traction, introduction to various electric drivetrain topologies, power flow control in electric drive-train topologies, fuel efficiency analysis, Electric Propulsion unit: Introduction to electric componentsused in electric vehicles,Types of Motors (DC, Induction, BLDC) and its working principles of EV, Function of Controllers and their use EV drives, Types of Sensors and their functions, Functional block diagram of each stage in brief, Scope of Development of EV drive system		
Mapping of Course Outcomes for Unit III	**CO3: Illustrate the Electric Drive Train System for EV.**	
Unit IV	**Energy Storage and Battery Management**	**(06Hrs.)**
Traditional battery system, Introduction to Energy Storage Requirements in Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Current battery Cell Types (Lead Acid/Li/NiMH), Use of supercapacitor and hydrogen fuel cell in EVs- necessity, advantages and specifications, Battery parameters: Cell and battery voltages, Charge (or Amphour) capacity, Energy stored, Energy density, Specific power, Amphour (or charge) efficiency, Energy efficiency, Self-discharge rates, Factors used in selection of energy storage device in case of EVs, Battery charging and discharging calculation, Battery selection criteria, Hybridization of different energy storage devices, Function of batteries in EV, Battery parameter, Vehicle Battery Management System (BMS)- block diagram, Need of BMS, Comparison of Batteries and scope of development, Upcoming technologies in battery.		
Mapping of Course Outcomes for Unit IV	**CO4: Select battery, battery indication system and battery management system for EV applications.**	
Unit V	**Electric Vehicle Architecture Design and Charging of batteries**	**(06Hrs.)**
Electrical protection and system requirement, Photovoltaic solar based EV design, Battery Electric vehicle (BEV), Hybrid electric vehicle (HEV), Plug-in hybrid vehicle (PHEV), Fuel cell electric vehicle (FCEV), Electrification Level of EV, Comparison of fuel vs Electric and solar power, Solar Power operated Electric vehicles, Basics of battery charging, Types of charging and its function, Points to be considered in design of charger, Types of chargers and working principles, Sources and utilization of renewable, energy for charging.		
Mapping of Course Outcomes for Unit V	**CO5: Understand Electric Vehicle Architecture Design and Charging Infrastructure.**	
Unit VI	**Electric Vehicles charging station and Challenges in Electric Vehicle**	**(06Hrs.)**

Type of Charging station, Selection and Sizing of charging station, Components of charging station, Single line diagram of charging station.
EV Design Challenges: Shorter Driving Range and Degrading Batteries, Selection of Power Semiconductors Charging and Infrastructure issues, EV Reliability, Electric vehicles and battery cost, Troubles shootings in drive trains, troubleshooting in batteries, Maintenances of EVs, Safety and precaution for EVs, No Universal charger and Ecosystem (Lack of standardization), EV charging standards.Advances in technology can help mitigate the challenges.

Mapping of Course Outcomes for Unit VI	**CO6: Illustrate the challenges in Electric Vehicle and solutions.**

Learning Resources

Text Books:

1. Emadi, A. (Ed.), Miller, J., Ehsani, M., "Vehicular Electric Power Systems" Boca Raton, CRC Press, 2003
2. Larminie, James, and John Lowry, "Electric Vehicle Technology Explained" John Wiley and Sons, 2012
3. SandeepDhameja, "Electric Vehicle Battery Systems", Newnes, 2000.

Reference Books:

4. Tom Denton- Electric & Hybrid vehicles - Institute of the Motor Industry.
5. MehrdadEhsani, YiminGao -Modern Electric, Hybrid Electric. & fuel Cell vehicles -CRC Press.
6. Tariq Muneer and Irene IllescasGarcía, "The automobile, In Electric Vehicles: Prospects and Challenges", Elsevier, 2017
7. Sheldon S. Williamson, "Energy Management Strategies for Electric and Plug-in Hybrid Electric Vehicles", Springer, 2013

MOOC / NPTEL Courses: Fundamentals of Electric vehicles: Technology & Economics, IIT Madras: https://nptel.ac.in/courses/108106170

Savitribai Phule Pune University
Final Year of Electronics & Computer Engineering (2019 Course)

410353C:Software Defined Radio (Elective VI)

Teaching Scheme:	Credit	Examination Scheme:
Theory: 03	**03**	**In-Sem (Theory): 30** **End Sem (Theory): 70**

Prerequisite Courses, if any:
1. Data Communication

Companion Course, if any: Nil

Course Objectives:

- To understand Software Defined Radio.
- To learn the architecture of SDR with specifications
- To understand significance of multi rate signal processing in SDR
- To learn SDR implementation with cognitive radio and challenges in SDR

Course Outcomes: On completion of the course, learner will be able to

CO1: To describe the basics of the software defined radio and Compare SDR with traditional Hardware Radio.

CO2: To describe the architecture of SDR with specifications and the alternative digital processing options in its architectural design.

CO3: To explain the significance of multi rate signal processing in SDR

CO4: To understand and explain the SDR implementation with cognitive radio through IEEE standards defined for CR.

CO5: To explain the importance of cognitive radio in wireless network

CO6: Understand challenges and implementation issues in applications of SDR

Course Contents

Unit I	Introduction to SDR	(06Hrs.)

Introduction to SDR, Need of SDR, The Requirement for Software-Defined Radio, Operational Requirements , Key Requirements, Reconfiguration ,Software/Hardware platform, GNU radio -What is GNU radio, GNU Radio Architecture, Hardware Block of GNU, GNU software , Radio Frequency Implementation issues.

Mapping of Course Outcomes for Unit I	CO1:To describe the basics of the software defined radio and Compare SDR with traditional Hardware Radio HDR.

Unit II	SDR Architecture	(06Hrs.)

Software Defined Radio Architectures, Ideal Software Defined Radio Architecture, Required Hardware Specifications, Transmitter Receiver Homodyne/heterodyne architecture, Digital Aspects of a Software Defined Radio, Digital Hardware, Alternative Digital Processing Options using DSP, FPGA and ASIC, Impact of Superconducting Technologies on Future SDR Systems		
Mapping of Course Outcomes for Unit II	**CO2: To describe the architecture of SDR with specifications and the alternative digital processing options in its architectural design.**	
Unit III	**Multi Rate Signal Processing**	**(06Hrs.)**
Sample timing algorithms, Frequency offset estimation and correction, Channel Estimation, Basics of Multi Rate, Multi Rate DSP, Multi Rate Algorithm, DSP techniques in SDR, OFDM in SDR		
Mapping of Course Outcomes for Unit III	**CO 3: To explain the significance of multi rate signal processing in SDR.**	
Unit IV	**Introduction to Cognitive Radio**	**(06Hrs.)**
Defining CR: History, Applications and Related Concepts , A Brief History of Elastic Spectrum Management ,A View of Wireless Network Futurists ,Ambiguity in CR Definitions ,Definition of Cognitive Radio Network ,Spectrum Management , Computational Platforms . CR Terminology Standardization - IEEE 1900.1 ,IEEE 1900.2 ,IEEE 1900.3 , IEEE 1900.4 , IEEE 1900.5 ,IEEE 1900.6, Related Standardization Efforts		
Mapping of Course Outcomes for Unit IV	**CO4: To understand and explain the SDR implementation with cognitive radio through IEEE standards defined for CR.**	
Unit V	**Cognitive Radio Architecture**	**(06Hrs.)**
Cognitive Radio network architecture– Resource manager frame work, architecture for spectrum sensing, network optimization through utilities , Value of Perfect Information ,Policy Support as a Part of the Architecture ,Spectrum Brokering Services Information Modelling, Topology Aware CRN Architectures - Statistical Characterization of Node Locations ,Spatial Statistics of Spectrum Usage, Publish-Subscribe CRN Architecture.		
Mapping of Course Outcomes for Unit V	**CO5: To explain the importance of cognitive radio in wireless network**	
Unit VI	**Applications of SDR**	**(06Hrs.)**
Application of SDR in Advance Communication System - Case Study, Challenges and Issues, Implementation, Parameter Estimation –Environment, Location, other factors, Vertical Handoff, Network Interoperability. Case Study : 1)CR for Public Safety –PSCR , Modes of PSCR, Architecture of PSCR, 2) Beagle board based SDR		
Mapping of Course Outcomes for Unit VI	**CO6: Understand challenges and implementation issues in applications of SDR**	
Learning Resources		

Text Books:

1. Jeffrey.H.Reed ,Software Radio : A Modern Approach to Radio Engineering , Pearson , LPE.
2. Kenington, Peter B.: RF and Baseband Techniques for Software Defined Radio, Artech House Publication

Reference Books:

1. Markus Dillinger , KambizMadani ,Nancy Alonistioti, Software Defined Radio : Architectures , Systems and Functions ,Wiley
2. Tony .J. Rouphael , RF and DSP for SDR, Elsevier Newness Press, 2008
3. BehrouzFarhang-Boroujeny, "Signal Processing Techniques for Software Radios", Lulu Publishing House, 2008.
4. Bruce a. Fette , "SDR –Handbook" , 8th Edition , PENTEK 5. Cognitive Radio Technology, Newness, Elsevier

MOOC / NPTEL Courses:

NPTEL Course "Basics of software defined radio**", Dr. MeenakshiRawat, IIT Roorkee**
Link of the Course:https://nptel.ac.in/courses/108107107

Savitribai Phule Pune University

BE Electronics and Computer Engineering (2019 Course)

410353D:Wireless Sensor Networks (Elective VI)

Teaching Scheme:	Credit:	Examination Scheme:
Theory: 03 hrs./week	03	In-Sem (Theory): 30 Marks End-Sem (Theory): 70 Marks

Prerequisite Courses, if any:

Companion Course, if any:

Course Objectives: To make the students understand

- To learn basic concepts of Wireless sensor networks
- To be familiar with architecture and protocols used in Wireless sensor networks
- To provide knowledge of deployment and security issued of Wireless sensor networks

Course Outcomes: After successfully completing the course, learner will be able to,

CO1: Illustrate various concepts and terminologies used in WSN and its architecture.
CO2: Describe importance and use of radio communication and link management in WSN.
CO3: Illustrate various wireless standards and protocols associated with WSN.
CO4: Recognize importance of localization and routing techniques used in WSN.
CO5: Understand techniques of clustering and importance of security in WSN.
CO6: Examine the issues in design and deployment of WSN.

Course Contents

Unit I	Introduction to Wireless Sensor Network	(07Hrs.)

What are Wireless Sensor Networks?, Wireless Sensor Node, Anatomy of a Sensor Node, Hardware components, Energy consumption of sensor nodes, Operating systems and execution environments, examples of sensor nodes, Architecture of WSN, Classification of WSN, Characteristics of WSN, Challenges in WSN, Performance metrics in WSN, Types of WSN. Topology used in WSN.

Mapping of Course Outcomes for Unit I	CO2: Illustrate various concepts and terminologies used in WSN and its architecture

Unit II	Radio Communication & Link Management	(07Hrs.)

WSN Standards- IEEE802.15.4 low rate WPAN, Zigbee, Wireless HART, IEEE802.15.3, Wibree, BLE, Protocol stack of WSNs, Fundamentals of MAC protocols, Low duty cycle protocols and wakeup concepts- S-MAC and B-MAC, contention based protocols, schedule based protocols, Cross Layer Protocol Stack.		
Mapping of Course Outcomes for Unit II	**CO2: Describe importance and use of radio communication and link management in WSN.**	
Unit III	**Wireless Standards & Protocol Stack**	**(07Hrs.)**
WSN Standards- IEEE802.15.4 low rate WPAN, Zigbee, Wireless HART, IEEE802.15.3, Wibree, BLE, Protocol stack of WSNs, Fundamentals of MAC protocols, Low duty cycle protocols and wakeup concepts- S-MAC and B-MAC, contention based protocols, schedule based protocols, Cross Layer Protocol Stack.		
Mapping of Course Outcomes for Unit III	**CO3: Illustrate various wireless standards and protocols associated with WSN.**	
Unit IV	**Localization & Routing in WSN**	**(07Hrs.)**
Localization: What is Localization Need of Localization in WSN, Localization Challenges and Properties, Deployment Schemes, Proximity Schemes, Ranging Schemes, Range-Based Localization, Range-Free Localization, **Routing:** Routing Basics, Routing Metrics, Routing Protocols: Issues in designing a routing protocol, classification of routing protocols, table-driven, on-demand, hybrid, flooding, hierarchical, and power aware routing protocols, Full-Network Broadcast, Location-Based Routing, Directed Diffusion, Collection Tree Protocol, Multi-Hop Communications.		
Mapping of Course Outcomes for Unit IV	**CO4: Recognize importance of localization and routing techniques used in WSN.**	
Unit V	**Clustering and Security Wireless Sensor Networks**	**(07Hrs.)**
Clustering in WSN: What is clustering? Clustering Goals and Necessity, Clustering Algorithms: Event-to-Sink Directed Clustering, Load balanced clustering scheme, K-means algorithm, Low-Energy Adaptive Clustering, Hybrid Energy-Efficient Distributed clustering, Adaptive distributed clustering algorithm (ADCA). **Security in WSN:** Security Requirements in WSN, Security issues and Challenges in WSN, Security Attacks in WSN, Various types of attacks in WSN Defensive Measures/Possible solution for attacks in WSN, Security requirements and threat model.		
Mapping of Course Outcomes for Unit V	**CO5: Understand techniques of clustering and importance of security in WSN.**	
Unit VI	**Design issues and Applications of WSN**	**(07Hrs.)**
Design issues: Design issues and challenges in Wireless Sensor Networks, Designing and Deploying WSN Applications, General Problems, General Testing and Validation, Requirements Analysis. QoS and Energy Management: Issues and Challenges in providing QoS, QoS frameworks, need for energy management, Comparison of Adhoc and Sensor Networks.		

Applications of WSN: Air Pollution Monitoring, Military applications, Smart home applications, Patient health monitoring, Weather Sensing and Monitoring (Block diagram and description).	
Mapping of Course Outcomes for Unit VI	**CO6: Examine the issues in design and deployment of WSN.**

Learning Resources

Text Books:

1. Dargie W. and Poellabauer C., "Fundamentals of Wireless Sensor Networks: Theory and Practice," John Wiley and Sons.
2. Anna Hac, "Wireless Sensor Network Designs," John Wiley and Sons.
3. Holger Karl and Andreas Willig, “Protocols and Architectures for Wireless Sensor Networks,” John Wiley and Sons.

Reference Books:

4. Edgar H. Callaway Jr. and Edgar H. Callaway, "Wireless Sensor Networks: Architectures and Protocols," CRC Press.
5. Sohraby K., Minoli D. and Znati T., "Wireless Sensor Networks: Technology, Protocols and Applications,” John Wiley and Sons

Savitribai Phule Pune University

BE Electronics and Computer Engineering (2019 Course)

410354:Laboratory Practice III

(Artificial Intelligence and Machine Learning and VLSI Design and Technology)

Teaching Scheme:	Credit:	Examination Scheme:
Practical: 04 hrs. / week	02	Practical: 50 Marks Termwork: 25 Marks

Artificial Intelligence and Machine Learning Lab.

List of Laboratory Experiments:

Group AArtificial Intelligence (Perform Any 3)

Implement the experiment using Python

1. Program for generating Fibonacci series
2. Implement Depth first search algorithm
3. Implement breadth first search algorithm
4. Implement A* approach for any suitable application.
5. Implement Greedy search algorithm for any of the following application:
   I. Selection Sort
   II.Minimum Spanning Tree
   III. Single-Source Shortest Path Problem
   IV. Job Scheduling Problem
   V.Prim's Minimal Spanning Tree Algorithm
6. Program to implement simple Chatbot

Group B: Machine Learning (Perform Any 5)

7. Write a python program to compute
   i) Central Tendency Measures: Mean, Median, Mode
   ii) Measure of Dispersion: Variance, Standard Deviation
8. Study of Python Basic Libraries such as Statistics, Math, Numpy and Scipy
9. Study of Python Libraries for ML application such as Pandas and Matplotlib
10. To extract features from given data set and establish training data.
11. To select relevant features using suitable technique.
12. Write a Python program to implement Simple Linear Regression
13. Implementation of Multiple Linear Regression for House Price Prediction using sklearn
14. Implementation of Decision tree using sklearn and its parameter tuning
15. Implement and test MLP trained with back-propagation algorithm
16. Implement SVM classifier for classification of data.

Group B: Artificial Neural Network (Perform Any 2)

17. Implementation of AND/NAND gate using feed forward Neural Network

18. Implementation of OR/NOR gate using feed forward Neural Network
19. Implementation of EX-OR gate using feed forward Neural Network

Savitribai Phule Pune University
BE Electronics and Computer Engineering (2019 Course)
VLSI Design and Technology Lab.

List of Laboratory Experiments

Part- A (Perform any five)

Modelling and Functional Simulation, synthesis and implementation on PLDs of the following digital circuits (with Xilinx/ ModelSim tools/Pyxis) using VHDL/Verilog Hardware Description Languages.(Three experiments are to be performed using VHDL and two using Verilog.)

1. Simulate all types of Flip-Flops using VHDL.
2. Arithmetic Logic Unit (ALU).
3. Parity generator
4. Cyclic Encoder / Decoder
5. Read Only Memory (ROM)/ Random Access Memory (RAM) implementation
6. Mealy State Machine/Moore State Machine-examples
7. Digital calculator

PART-B (Perform any four)

Experiments shall be carried out using Mentor Graphics/Cadence Tools/Microwind/ Any open source software for layout design.

Schematic Entry/ Simulation / Layout/ DRC/PEX/Post Layout Simulation of:

CMOS Inverter

8. NAND Gate/ OR Gate
9. 2:1 Multiplexer
10. D- Latch / Flip Flop
11. Single bit SRAM Cell

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BE Electronics and Computer Engineering (2019 Course)

410355:Laboratory Practice IV

Elective V Lab

Teaching Scheme:	Credit:	Examination Scheme:
Practical: 02 hrs. / week	02	Oral: 50 Marks Termwork: 25 Marks

Cloud Computing: Elective V Lab

Prerequisite Courses, if any:

Companion Course, if any:

List of Laboratory Experiments:

ListofAssignments

1. Install Google App Engine. Create hello world app and other simple web applications usingpython/java.
2. Installation and configuration of own Cloud
3. Write a program for Web feed using PHP and HTML
4. Use GAE launcher to launch the web applications.
5. Simulate a cloud scenario using CloudSim and run a scheduling algorithm that is not present inCloudSim.
6. Find a procedure to transfer the files from one virtual machine to another virtual machine.
7. Find a procedure to launch virtual machine using trystack (Online Openstack Demo Version)
8. Design and deploy a web application in a PaaS environment.
9. Design and develop custom Application (Mini Project) using Salesforce Cloud.
10. Design an Assignment to retrieve, verify, and store user credentials using Firebase Authentication,the Google App Engine standard environment, and Google Cloud Data store.

Case Studies

- Data storage security in private cloud
- Application of IoT/Ubiquitous based on cloud
- Tools for building private cloud

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BE Electronics and Computer Engineering (2019 Course)

Embedded System and Real Time Operating Systems :Elective V Lab

Prerequisite Courses, if any:

Companion Course, if any:

List of Laboratory Experiments

Group A (All Experiment Compulsory)

1. Multitasking in µCOS II RTOS using minimum 3 tasks on ARM7/ ARM Cortex- M3.
2. Semaphore as signaling & Synchronizing on ARM7/ ARM Cortex- M3.
3. Mailbox implementation for message passing on ARM7/ ARM Cortex- M3.
4. Queue implementation for message passing on ARM7/ ARM Cortex- M3.
5. Implementation of MUTEX using minimum 3 tasks on ARM7/ ARM Cortex- M3.

Group B (Perform Any 2)

6. Download pre-configured Kernel Image, File System, boot loader to target device- ARM9.
7. Writing simple application using embedded Linux on ARM9.
8. Writing "Hello World" device Driver. Loading into & removing from Kernel on ARM9 board. 9. Write a program for I2C based RTC using embedded Linux on ARM9.
9. Using Device driver for GPIO, write a program to blink LED onARM9.

Group C (Perform Any 3)

10. Interfacing of LED with Arduino and program for blinking LED.
11. Interfacing LDR, Gas sensor with Arduino board and program for the same
12. Interfacing of DC motor with Arduino and program for speed control of dc motor using PWM
13. Interfacing temperature sensor LM35 with Arduino board and program to display temperature

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BE Electronics and Computer Engineering (2019 Course)

Software Testing and Quality Assurance:Elective V Lab

Prerequisite Courses, if any:

Companion Course, if any:

List of Laboratory Experiments:

Preform any 08

1. Create a test plan document for any application (e.g-Library management system)
2. Preparation of software requirement specification (SRS) document.
3. Write the test cases for GMAIL , FACEBOOK,TWITTER etc.,
4. Study of Test Cases for Mobile Application Testing.
5. Take any systems (e.g-ATM Systems) and study its system specifications and report the various bugs.
6. Write the test cases of any known applications (e.g-Banking Applications, Telecom domain)
7. Study of any manual testing tool.
8. Study of Automation testing tool to test any application or webpage. (e.g-Selenium)

9. Study of any bug tracking tools.
10. Experiment: Study of any open source testing tool

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BE Electronics and Computer Engineering (2019 Course)

Artificial Neural Network:Elective V Lab

Prerequisite Courses, if any:

Companion Course, if any:

List of Laboratory Experiments:

Group A (Perform Any 5)

1. Implementing Artificial Neural Network training process in Python
2. Implementation of AND/NAND gate using feed forward Neural Network
3. Implementation of OR/NOR gate using feed forward Neural Network
4. Implementation of EX-OR gate using feed forward Neural Network
5. Implementation of AND/OR/NOT Gate using Single Layer Perceptron
6. Implementation of XOR Gate Using Multi-Layer Perceptron/ Error Back Propagation

Group B (Perform Any 2)

7. Implementation of XOR Gate Using Radial Basis Function Network
8. Understanding the concepts of Perceptron Learning Rule
9. Understanding the concepts of Hebbiann Learning Rule
10. Understanding the concepts of Correlation Learning Rule

Group C (Perform Any 2)

11. To Build and train of Convolutional Neural Network in Python
12. Handwritten Digit Recognition using CNN
13. Case study of Traffic Signs Recognition using CNN & Keras in Python
14. Case study Chatbot implementation using CNN in Python

Virtual LAB Links:

1.Lab Name: Machine Learning Lab
http://vlabs.iitb.ac.in/vlabs-dev/labs/machine_learning/labs/index.php

2.Lab Name: AI-Deep Learning Virtual Labs: AI Made Easy
Link of the Virtual Lab: https://vlab.spit.ac.in/ai/#/experiments

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BE Electronics and Computer Engineering (2019 Course)

410356:Project Stage II

Teaching Scheme:	Credit:	Examination Scheme:
Practical: 08 hrs. / week	04	Oral: 50 Marks Termwork: 100 Marks

Prerequisite Courses, if any: BE-Project Stage I – Semester I.

Companion Course, if any:

Course Objectives:

1. Project Stage II objective is to enable the students to continue the investigative study they initiated in Project Stage I , under the guidance of supervisor or project guide from the department.To expose the students to product development cycle through industrial experience and the use of state-of-the-art technologies.
2. To encourage and expose students to national/international paper presentation activities and funding agencies for sponsored projects.
3. Exposure to methods for learning and accessing knowledge that involve conferences, journal articles, and anticipation of research projects.
4. To evaluate the various validation and verification methods and to validate the work undertaken.
5. Analyzing professional issues, including ethical, legal and security issues, related to computing projects.

Course Outcomes:

By the end of the course, Students will be able to

1. Learn teamwork.
2. Show evidence of independent investigation.
3. Critically analyze the results and their interpretation.
4. Get exposure of various types of testing methods and tools.
5. Understand the importance of documentation
6. Analyzing professional issues, including ethical, legal and security issues, related to computing projects.

Important Note: One paper should be published in reputed International conference/International Journal.

NOTE:

The group should maintain a logbook of activities. It should have entries related to the work done,problems faced, solution evolved etc., duly signed by internal guide and HODs. Project report must be submitted in the prescribed format only. No variation in the format will be accepted. One guide will

be assigned at the most 03 project groups.

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BE Electronics and Computer Engineering (2019 Course)

410349B:MandatoryAudit Course 8: Business Intelligence

Course Objectives:

1. To understand the concept of Business Intelligence
2. To know the details of Decision Support System
3. To inculcate the concepts of Data Warehousing
4. To understand the basics of design and management of BI systems

Course Outcomes: On completion of the course, learner will be able to -

CO1: Apply the concepts of Business Intelligence in real world applications
CO2: Explore and use the Decision Making Concepts wherever necessary
CO3: Explore and use the data warehousing wherever necessary
CO4: Explore and use the Data Pre-processing and outliers wherever necessary
CO5: Design and manage practical BI systems

Course Contents

1. Concepts with Mathematical treatment **:** Introduction to data, Information and knowledge, Decision Support System, Theory of Operational data and informational data, Introduction to Business Intelligence, Determining BI Cycle, BI Environment and Architecture, Identify BI opportunities, Benefits of BI. Role of Mathematical model in BI, Factors Responsible for successful BI Project, Obstacle to Business Intelligence in an Organization.
2. Concepts of Decision Making, Techniques of Decision Support System (DSS), Development of Decision Support System (DSS), Applications of DSS, Role of Business Intelligence in DSS.
3. Introduction: Data warehouse Modeling, data warehouse design, data-ware-house technology, Distributed data warehouse, and materialized view.
4. Testing Android applications, Publishing Android application, Using Android preferences, Managing Application resources in a hierarchy, working with different types of resources.
5. Using Common Android APIs**:** Using Android Data and Storage APIs, Managing data using SQLite, Sharing Data between Applications with Content Providers, Using Android Networking APIs, Using Android Web APIs, Using Android Telephony APIs, Deploying Android Application to the World.

Learning Resources

Text Books:

1. R. Sharda, D. Delen, and E. Turban, Business Intelligence and Analytics. Systems for Decision Support,10th Edition. Pearson/Prentice Hall, 2015. ISBN-13: 978-0-13-305090-5, ISBN-10: 0-13-305090-4;
2. Business Process Automation, Sanjay Mohapatra, PHI.

Reference Books:

1. Introduction to business Intelligence and data warehousing, IBM, PHI, ISBN: 9788120339279

Savitribai Phule Pune University
BE Electronics and Computer Engineering (2019 Course)
410349B:MandatoryAudit Course 8: Quantum Computing

Course Objectives:

- To understand basic concepts of quantum computing
- To learn quantum search algorithms
- To apply quantum information for solving real world problem

Course Outcome:

On completion of the course, learner will be able to–

- design efficient quantum algorithms
- apply quantum algorithms for several basic promise problems
- learn the hidden subgroup problems and their role in quantum computing

Course Contents

1. **Fundamental concepts:** Introduction and overview, Quantum computation, quantum algorithm, Introduction to quantum mechanics, The postulates of quantum mechanics.
2. **Quantum computation:** Quantum circuits, The quantum Fourier transform and its applications, Quantum search algorithms, Quantum computers: physical realization.
3. **Quantum information:** Quantum noise and quantum operations, Distance measures for quantum information, Quantum error-correction, mEntropy and information, Quantum information theory.

Books:

1. Michael A. Nielsen and Isaac L. Chuang, “Quantum Computation and Quantum Information”, ISBN: 9780521635035.
2. Mikio Nakahara and Tetsuo Ohmi, "Quantum Computing", CRC Press 2008.
3. N. David Mermin, "Quantum Computer Science", Cambridge 2007

Savitribai Phule Pune University
BE Electronics and Computer Engineering (2019 Course)
410349B:MandatoryAudit Course 8: Cognitive Computing

Course Objectives:

1. To develop algorithms that use AI and machine learning along with human interaction and feedback to help humans make choices/decisions.
2. To get the detailed about appealing new model for application development.
3. To understand how to evaluate patterns and complex relationships in large unstructured data sets.
4. To understand how Cognitive computing supports human reasoning by evaluating data in context and

presenting relevant findings along with the evidence that justifies the answers.

Course Outcomes:

By the end of the course, students should be able to

1. Understand and discuss what cognitive computing is, and how it differs from traditional approaches.
2. Plan and use the primary tools associated with cognitive computing.
3. Plan and execute a project that leverages cognitive computing.
4. Understand and discuss the business implications of cognitive computing.

Course Contents

1. **Introduction to Cognitive Systems and computation, Knowledge based AI**
   Cognitive systems, Different modes of Computing: Turning machine Lambda, Calculus, Hyper Computing, Super Computing, Pan Computing and Interactive Computing.
2. **Cognitive Functioning**
   Learning, Memorising, Adaptation, Self Origination, Control, Thinking, Reasoning, Decision Making &Judgement.
3. **Mental States**
   Belief Desire Intention (BDI) emotion and feeting. Computation of Cognitive Functioning in machines: Robotics, Human Robotics Interaction, Hepatic.
4. **Perception and sensing**:
   Hardware machines of vision and audition with reference to human and machine.

References

Hurwitz, Kaufman, and Bowles, Cognitive Computing and Big Data Analytics, Wiley, Indianapolis, IN, 2005, ISBN: 978-1-118-89662-4.

Savitribai Phule Pune University
BE Electronics and Computer Engineering (2019 Course)
410349B:MandatoryAudit Course 8: Technologies, Disruptions and EntrepreneurialOpportunities

Background: Since last few decades, technologies are improving at exponential rates. The college curriculum cannot be modified to ensure inclusion of these new developments. Therefore, this audit course is designed to give a high level overview of the new exponential technologies, resulting disruptions in businesses and opportunities getting created for entrepreneurs.

Pre-Requisites: One year of technology courses in any department of engineering college.

Course Objectives: To make the students understand

1. To understand the process of growth of exponential technologies and the resultant disruptive scenarios in business, social, government sectors of economy.
2. To understand the few exponentially growing technologies and few business scenarios where disruptions are expected.
3. To understand where the entrepreneurial opportunities are emerging and how new engineers will be

able to exploit these opportunities.

Course Outcomes: On completion of the course, learner will be able to -

1. Students will have better understanding of the process of technology trends leading to Business Disruptions and entrepreneurial opportunities.
2. Students will appreciate the technologies that they need to learn independently to better achieve their entrepreneurial career goals.

Course Contents

1. Introduction

The process of emerging new technologies with exponential growth potential, how these exponential technologies lead to business disruptions, opportunities created for new businesses, destruction caused of established players, evolution of new businesses, Unicorns.

2. Emerging Exponential Technologies

Understand Technology trends worldwide and identify the potential emerging exponential technologies like, Social, Mobile, Analytics, Computing (SMAC), Genetics, AI, 3D, Solar/Wind/Renewable, blockchain.

3. Emerging Business Disruptions and Business models

Learn business trends worldwide and identify potential business disruptions in multiple sectors like, Healthcare, Transportation, Weapons, Governance, Space, Energy, Finance and Education. Learn the new innovative business models.

4. Identify Entrepreneurial Opportunities and Conclusions

Identify use cases and jobs to be done, customer pains and gains, solution development, prototype, problem-solution fit, product–marketfit, customer development and validation.

ReferenceBooks:

1. Innovator'sDilemma byClaytonChristenson(http://hbx.hbs.edu/hbx-courses/disruptive-strategy.html)
2. Disruption:EmergingTechnologiesandtheFutureofWorkbyVictordelRosal(Paperback)
3. MasteringtheHypeCycle:HowtoChoosetheRightInnovationattheRightTimebyJackieFenn,MarkRaskino(Hardcover)
4. TheLeanStartup:HowToday'sEntrepreneursUseContinuousInnovationto Create RadicallySuccessfulBusinesses byEric Ries(Hardcover)
5. ExponentialOrganizations:Whyneworganizationsaretentimes better, faster, andcheaperthanyours(andwhattodoaboutit) by Salim Ismail ,MichaelS.Malone,YurivanGeest(Paperback)
6. Abundance: The Future Is Better Than You ThinkbyPeterH.Diamandis,StevenKotler(Paperback)
7. WhartononManaging EmergingTechnologiesbyGeorgeS.DayandPaulJ.H.Schoemaker.