Faculty of Engineering
Savitribai Phule Pune University, Pune

Maharashtra, India

Syllabus

for

Fourth Year of Computer Engineering
(2015 Course)

(with effect from 2018-19)

Prologue

It is with great pleasure and honor that I share the syllabi for Fourth Year of Computer Engineering (2015 Course) on behalf of Board of Studies (BoS), Computer Engineering. We, members of BoS are giving our best to streamline the processes and curricula design at both UG and PG programs.

It is always the strenuous task to balance the syllabus with the blend of core subjects, current developments and exotic subjects. By considering all the aspects with adequate prudence the contents are designed to make the graduate competent enough as far as employability is concerned. It is absolutely necessary and justified to add sufficient flexibility in the given constraints leading the curriculum design near to perfection.

It may be highly subjective to include or exclude the courses, but benefit of the learner is always the nucleus the process. Many thoughts, suggestions, recommendations and directions help us to come up with the final contents. For the final year finishing touch is absolutely necessary which is provided with project based learning at the most.

I sincerely thank all the minds and hands who work adroitly to materialize these tasks. I really appreciate everyone's contribution and suggestions in finalizing the contents.

Dr. Varsha H. Patil
Coordinator, Board of Studies (Computer Engineering), SPPU, Pune

[This document contents Program Educational Objectives - Program Outcomes - Program Specific Outcomes(page 3),Courses (teaching scheme, examination, marks and credit)(page 4-5), Courses syllabi(page 7-85) and FE to BE courses at a glance(Page 86-87)].

Other related Syllabus Links:
Syllabus for First Year Engineering (2015 Course)
Syllabus for Second Year Computer Engineering (2015 Course)
Syllabus for Third Year Computer Engineering (2015 Course)

Savitribai Phule Pune University, Pune
Bachelor of Computer Engineering

Program Educational Objectives

1. To prepare globally competent graduates having strong fundamentals, domain knowledge, updated with modern technology to provide the effective solutions for engineering problems.
2. To prepare the graduates to work as a committed professional with strong professional ethics and values, sense of responsibilities, understanding of legal, safety, health, societal, cultural and environmental issues.
3. To prepare committed and motivated graduates with research attitude, lifelong learning, investigative approach, and multidisciplinary thinking.
4. To prepare the graduates with strong managerial and communication skills to work effectively as individual as well as in teams.

Program Outcomes

Students are expected to know and be able –

1. To apply knowledge of mathematics, science, engineering fundamentals, problem solving skills, algorithmic analysis and mathematical modeling to the solution of complex engineering problems.
2. To analyze the problem by finding its domain and applying domain specific skills
3. To understand the design issues of the product/software and develop effective solutions with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.
4. To find solutions of complex problems by conducting investigations applying suitable techniques.
5. To adapt the usage of modern tools and recent software.
6. To contribute towards the society by understanding the impact of Engineering on global aspect.
7. To understand environment issues and design a sustainable system.
8. To understand and follow professional ethics.
9. To function effectively as an individual and as member or leader in diverse teams and interdisciplinary settings.
10. To demonstrate effective communication at various levels.
11. To apply the knowledge of Computer Engineering for development of projects, and its finance and management.
12. To keep in touch with current technologies and inculcate the practice of lifelong learning.

Program Specific Outcomes (PSO)

A graduate of the Computer Engineering Program will demonstrate-

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

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

PSO3: Successful Career and Entrepreneurship- The ability to employ modern computer languages, environments, and platforms in creating innovative career paths to be an entrepreneur, and a zest for higher studies.

Savitribai Phule Pune University
Fourth Year of Computer Engineering (2015 Course)
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Semester I

Course Code	Course	Teaching Scheme Hours / Week		Examination Scheme and Marks						Credit	
		Theory	Practical	In-Sem	End-Sem	TW	PR	OR/ *PRE	Total	TH/ TUT	PR
410241	High Performance Computing	04	--	30	70	--	--	--	100	04	--
410242	Artificial Intelligence and Robotics	03	--	30	70	--	--	--	100	03	--
410243	Data Analytics	03	--	30	70	--	--	--	100	03	--
410244	Elective I	03	--	30	70	--	--	--	100	03	--
410245	Elective II	03	--	30	70	--	--	--	100	03	--
410246	Laboratory Practice I	--	04	--	--	50	50	--	100	--	02
410247	Laboratory Practice II	--	04	--	--	50	--	*50	100	--	02
410248	Project Work Stage I	--	02	--	--	--	--	*50	50	--	02
								Total Credit		16	06
Total		**16**	**10**	**150**	**350**	**100**	**50**	**100**	**750**	**22**	
410249	Audit Course 5									**Grade**	

Elective I	Elective II
410244 (A) Digital Signal Processing	410245 (A) Distributed Systems
410244 (B) Software Architecture and Design	410245 (B) Software Testing and Quality Assurance
410244 (C) Pervasive and Ubiquitous Computing	410245 (C) Operations Research
410244 (D) Data Mining and Warehousing	410245 (D) Mobile Communication

410249-Audit Course 5 (AC5) Options:

AC5-I	Entrepreneurship Development	**AC5-IV:**	Industrial Safety and Environment Consciousness
AC5-II:	Botnet of Things	**AC5-V:**	Emotional Intelligence
AC5-III:	3D Printing	**AC5-VI:**	MOOC- Learn New Skills

Abbreviations:

TW: Term Work　　**TH:** Theory　　**OR:** Oral　　**PR:** Practical

Sem: Semester　　***PRE**: Project/ Mini-Project Presentation

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Fourth Year of Computer Engineering (2015 Course)
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Semester II

Course Code	Course	Teaching Scheme Hours / Week		Examination Scheme and Marks						Credit	
		Theory	Practical	In-Sem	End-Sem	TW	PR	OR/ *PRE	Total	TH/ TUT	PR
410250	Machine Learning	03	--	30	70	--	--	--	100	03	--
410251	Information and Cyber Security	03	--	30	70	--	--	--	100	03	--
410252	Elective III	03	--	30	70	--	--	--	100	03	--
410253	Elective IV	03	--	30	70	--	--	--	100	03	--
410254	Laboratory Practice III	--	04	--	--	50	50	--	100	--	02
410255	Laboratory Practice IV	--	04	--	--	50	--	*50	100	--	02
410256	Project Work Stage II	--	06	--	--	100	--	*50	150	02	04
								Total Credit		12	10
Total		**12**	**14**	**120**	**280**	**200**	**50**	**100**	**750**	**22**	
410257	Audit Course 6									Grade	

Elective III	Elective IV
410252 (A) Advanced Digital Signal Processing	410253 (A) Software Defined Networks
410252 (B) Compilers	410253 (B) Human Computer Interface
410252 (C) Embedded and Real Time Operating Systems	410253 (C) Cloud Computing
410252 (D) Soft Computing and Optimization Algorithms	410253 (D) Open Elective

410259-Audit Course 6 (AC6) Options:

AC6-I: Business Intelligence   AC6-IV: Usability Engineering
AC6-II: Gamification   AC6-V: Conversational Interfaces
AC6-III: Quantum Computing   AC6-VI: MOOC- Learn New Skills

Abbreviations:

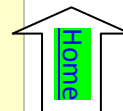**TW:** Term Work   **TH:** Theory   **OR:** Oral   **PR:** Practical

Sem: Semester   ***PRE**: Project/ Mini-Project Presentation

SEMESTER

I

Savitribai Phule Pune University
Fourth Year of Computer Engineering (2015 Course)
410241: High Performance Computing

Teaching Scheme: TH: 04 Hours/Week	Credit 04	Examination Scheme: In-Sem (Paper): 30 Marks End-Sem (Paper): 70 Marks

Prerequisite Courses: 210253-Microprocessor, 210244- Computer Organization and Architecture, 210254-Principles of Programming Languages, 310251- Systems Programming and Operating System

Companion Course: 410246-Laboratory Practice I

Course Objectives:

- To study parallel computing hardware and programming models
- To be conversant with performance analysis and modeling of parallel programs
- To understand the options available to parallelize the programs
- To know the operating system requirements to qualify in handling the parallelization

Course Outcomes:

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

- Describe different parallel architectures, inter-connect networks, programming models
- Develop an efficient parallel algorithm to solve given problem
- Analyze and measure performance of modern parallel computing systems
- Build the logic to parallelize the programming task

Course Contents

Unit I	Introduction	09 Hours

Motivating Parallelism, Scope of Parallel Computing, Parallel Programming Platforms: Implicit Parallelism, Trends in Microprocessor and Architectures, Limitations of Memory, System Performance, Dichotomy of Parallel Computing Platforms, Physical Organization of Parallel Platforms, Communication Costs in Parallel Machines, Scalable design principles, Architectures: N-wide superscalar architectures, Multi-core architecture.

Unit II	Parallel Programming	09 Hours

Principles of Parallel Algorithm Design: Preliminaries, Decomposition Techniques, Characteristics of Tasks and Interactions, Mapping Techniques for Load Balancing, Methods for Containing Interaction Overheads, Parallel Algorithm Models, The Age of Parallel Processing, the Rise of GPU Computing, A Brief History of GPUs, Early GPU.

Unit III	Basic Communication	09 Hours

Operations- One-to-All Broadcast and All-to-One Reduction, All-to-All Broadcast and Reduction, All-Reduce and Prefix-Sum Operations, Scatter and Gather, All-to-All Personalized Communication, Circular Shift, Improving the Speed of Some Communication Operations.

Unit IV	Analytical Models of Parallel Programs	09 Hours

Analytical Models: Sources of overhead in Parallel Programs, Performance Metrics for Parallel Systems, and The effect of Granularity on Performance, Scalability of Parallel Systems, Minimum execution time and minimum cost, optimal execution time. Dense Matrix Algorithms: Matrix-Vector Multiplication, Matrix-Matrix Multiplication.

Unit V	Parallel Algorithms- Sorting and Graph	09 Hours

Issues in Sorting on Parallel Computers, Bubble Sort and its Variants, Parallelizing Quick sort, All-Pairs Shortest Paths, Algorithm for sparse graph, Parallel Depth-First Search, Parallel Best-First Search.

Unit VI	CUDA Architecture	09 Hours

CUDA Architecture, Using the CUDA Architecture, Applications of CUDA Introduction to CUDA C-Write and launch CUDA C kernels, Manage GPU memory, Manage communication and synchronization, Parallel programming in CUDA- C.

Books:

Text:

1. Ananth Grama, Anshul Gupta, George Karypis, and Vipin Kumar, "Introduction to Parallel Computing", 2nd edition, Addison-Wesley, 2003, ISBN: 0-201-64865-2
2. Jason sanders, Edward Kandrot, "CUDA by Example", Addison-Wesley, ISBN-13: 978-0-13-138768-3

References:

1. Kai Hwang, "Scalable Parallel Computing", McGraw Hill 1998, ISBN:0070317984
2. Shane Cook, "CUDA Programming: A Developer's Guide to Parallel Computing with GPUs", Morgan Kaufmann Publishers Inc. San Francisco, CA, USA 2013 ISBN: 9780124159884
3. David Culler Jaswinder Pal Singh, "Parallel Computer Architecture: A Hardware/Software Approach", Morgan Kaufmann,1999, ISBN 978-1-55860-343-1
4. Rod Stephens, " Essential Algorithms", Wiley, ISBN: 978-1-118-61210-1
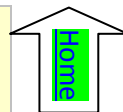
Savitribai Phule Pune University
Fourth Year of Computer Engineering (2015 Course)
410242: Artificial Intelligence and Robotics

Teaching Scheme: TH: 03 Hours/Week	Credit 03	Examination Scheme: In-Sem (Paper): 30 Marks End-Sem (Paper): 70 Marks

Prerequisite Courses: 210254-Principles of Programming Languages

Companion Course: 410246-Laboratory Practice I

Course Objectives:

- To understand the concept of Artificial Intelligence (AI)
- To learn various peculiar search strategies for AI
- To acquaint with the fundamentals of mobile robotics
- To develop a mind to solve real world problems unconventionally with optimality

Course Outcomes:

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

- Identify and apply suitable Intelligent agents for various AI applications
- Design smart system using different informed search / uninformed search or heuristic approaches.
- Identify knowledge associated and represent it by ontological engineering to plan a strategy to solve given problem.
- Apply the suitable algorithms to solve AI problems

Course Contents

Unit I	Introduction	08 Hours

Artificial Intelligence: Introduction, Typical Applications. State Space Search: Depth Bounded DFS, Depth First Iterative Deepening. Heuristic Search: Heuristic Functions, Best First Search, Hill Climbing, Variable Neighborhood Descent, Beam Search, Tabu Search. Optimal Search: A* algorithm, Iterative Deepening A*, Recursive Best First Search, Pruning the CLOSED and OPEN Lists.

Unit II	Problem Decomposition and Planning	08 Hours

Problem Decomposition: Goal Trees, Rule Based Systems, Rule Based Expert Systems. Planning: STRIPS, Forward and Backward State Space Planning, Goal Stack Planning, Plan Space Planning, A Unified Framework For Planning. Constraint Satisfaction : N-Queens, Constraint Propagation, Scene Labeling, Higher order and Directional Consistencies, Backtracking and Look ahead Strategies.

Unit III	Logic and Reasoning	08 Hours
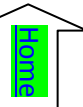
Knowledge Based Reasoning: Agents, Facets of Knowledge. Logic and Inferences: Formal Logic, Propositional and First Order Logic, Resolution in Propositional and First Order Logic, Deductive Retrieval, Backward Chaining, Second order Logic. Knowledge Representation: Conceptual Dependency, Frames, Semantic nets.

Unit IV	Natural Language Processing and ANN	08 Hours

Natural Language Processing: Introduction, Stages in natural language Processing, Application of NLP in Machine Translation, Information Retrieval and Big Data Information Retrieval. Learning: Supervised, Unsupervised and Reinforcement learning. **Artificial Neural Networks** (ANNs): Concept, Feed forward and Feedback ANNs, Error Back Propagation, Boltzmann Machine.

Unit V	Robotics	08 Hours

Robotics: Fundamentals, path Planning for Point Robot, Sensing and mapping for Point Robot, Mobile Robot Hardware, Non Visual Sensors like: Contact Sensors, Inertial Sensors, Infrared Sensors, Sonar, Radar, laser Rangefinders, Biological Sensing. Robot System Control: Horizontal and Vertical Decomposition, Hybrid Control Architectures, Middleware, High-Level Control, Human-Robot Interface.

Unit VI	Robots in Practice	08 Hours

Robot Pose Maintenance and Localization: Simple Landmark Measurement, Servo Control, Recursive Filtering, Global Localization. Mapping: Sensorial Maps, Topological Maps, Geometric Maps, Exploration. Robots in Practice: Delivery Robots, Intelligent Vehicles, Mining Automation, Space Robotics, Autonomous Aircrafts, Agriculture, Forestry, Domestic Robots.

Books:

Text:
1. Deepak Khemani, "A First Course in Artificial Intelligence", McGraw Hill Education(India), 2013, ISBN : 978-1-25-902998-1
2. Elaine Rich, Kevin Knight and Nair, "Artificial Intelligence", TMH, ISBN-978-0-07-008770-5
3. Stuart Russell and Peter Norvig, "Artificial Intelligence: A Modern Approach", Third edition, Pearson, 2003, ISBN :10: 0136042597
4. Michael Jenkin, Gregory, " Computational Principals of Mobile Robotics", Cambridge University Press, 2010, ISBN : 978-0-52-187157-0

References:

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. Andries P. Engelbrecht-Computational Intelligence: An Introduction, 2nd Edition-Wiley India- ISBN: 978-0-470-51250-0
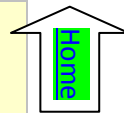
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Fourth Year of Computer Engineering (2015 Course)
410243: Data Analytics

Teaching Scheme: TH: 03 Hours/Week	Credit 03	Examination Scheme: In-Sem (Paper): 30 Marks End-Sem (Paper): 70 Marks

Prerequisite Courses: 310242-Database Management Systems

Companion Course: 410246-Laboratory Practice I

Course Objectives:

- To develop problem solving abilities using Mathematics
- To apply algorithmic strategies while solving problems
- To develop time and space efficient algorithms
- To study algorithmic examples in distributed, concurrent and parallel environments

Course Outcomes:

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

- Write case studies in Business Analytic and Intelligence using mathematical models
- Present a survey on applications for Business Analytic and Intelligence
- Provide problem solutions for multi-core or distributed, concurrent/Parallel environments

Course Contents

Unit I	Introduction and Life Cycle	08 Hours

Introduction: Big data overview, state of the practice in Analytics- BI Vs Data Science, Current Analytical Architecture, drivers of Big Data, Emerging Big Data Ecosystem and new approach.
Data Analytic Life Cycle: Overview, phase 1- Discovery, Phase 2- Data preparation, Phase 3- Model Planning, Phase 4- Model Building, Phase 5- Communicate Results, Phase 6- Opearationalize. Case Study: GINA

Unit II	Basic Data Analytic Methods	08 Hours

Statistical Methods for Evaluation- Hypothesis testing, difference of means, wilcoxon rank–sum test, type 1 type 2 errors, power and sample size, ANNOVA. Advanced Analytical Theory and Methods: Clustering- Overview, K means- Use cases, Overview of methods, determining number of clusters, diagnostics, reasons to choose and cautions.

Unit III	Association Rules and Regression	08 Hours

Advanced Analytical Theory and Methods: Association Rules- Overview, a-priori algorithm, evaluation of candidate rules, case study-transactions in grocery store, validation and testing, diagnostics. Regression- linear, logistics, reasons to choose and cautions, additional regression models.

Unit IV	Classification	08 Hours

Decision trees- Overview, general algorithm, decision tree algorithm, evaluating a decision tree. Naïve Bayes – Bayes' Algorithm, Naïve Bayes' Classifier, smoothing, diagnostics. Diagnostics of classifiers, additional classification methods.

Unit V	Big Data Visualization	08 Hours

Introduction to Data visualization, Challenges to Big data visualization, Conventional data visualization tools, Techniques for visual data representations, Types of data visualization, Visualizing Big Data, Tools used in data visualization, Analytical techniques used in Big data visualization.

Unit VI	Advanced Analytics-Technology and Tools	08 Hours

Analytics for unstructured data- Use cases, Map Reduce, Apache Hadoop. The Hadoop Ecosystem- Pig, HIVE, HBase, Mahout, NoSQL. An Analytics Project-Communicating, operationalizing, creating final deliverables.
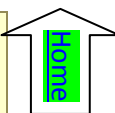
Books:

Text:

1. David Dietrich, Barry Hiller, "Data Science and Big Data Analytics", EMC education services, Wiley publications, 2012, ISBN0-07-120413-X
2. Ashutosh Nandeshwar , "Tableau Data Visualization Codebook", Packt Publishing, ISBN 978-1-84968-978-6

References:

1. Maheshwari Anil, Rakshit, Acharya, "Data Analytics", McGraw Hill, ISBN: 789353160258.
2. Mark Gardner, "Beginning R: The Statistical Programming Language", Wrox Publication, ISBN: 978-1-118-16430-3
3. Luís Torgo, "Data Mining with R, Learning with Case Studies", CRC Press, Talay and Francis Group, ISBN9781482234893
4. Carlo Vercellis, "Business Intelligence - Data Mining and Optimization for Decision Making", Wiley Publications, ISBN: 9780470753866.

Savitribai Phule Pune University
Fourth Year of Computer Engineering (2015 Course)
Elective I
410244(A): Digital Signal Processing

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

Prerequisite Courses: 207003- Engineering Mathematics III

Companion Course: 410247-Laboratory Practice II

Course Objectives:
- To Study and understand representation and properties of signals and systems.
- To learn methodology to analyze signals and systems
- To study transformed domain representation of signals and systems
- To explore Design and analysis of Discrete Time (DT) signals and systems
- To Understand Design of filters as DT systems
- To get acquainted with the DSP Processors and DSP applications

Course Outcomes:

On completion of the course, student will be able to–
- Understand the mathematical models and representations of DT Signals and Systems
- Apply different transforms like Fourier and Z-Transform from applications point of view.
- Understand the design and implementation of DT systems as DT filters with filter structures and different transforms.
- Demonstrate the knowledge of signals and systems for design and analysis of systems
- Apply knowledge and use the signal transforms for digital processing applications

Course Contents		
Unit I	**Signals and Systems**	**08 Hours**

Continuous time (CT), Discrete-time (DT) and Digital signals, Basic DT signals and Operations. Discrete-time Systems, Properties of DT Systems and Classification, Linear Time Invariant (LTI) Systems, Impulse response, Linear convolution, Linear constant coefficient difference equations, FIR and IIR systems, Periodic Sampling, Relationship between Analog and DT frequencies, Aliasing, Sampling Theorem, A to D conversion Process: Sampling, quantization and encoding.

Unit II	**Frequency Domain Representation of Signal**	**08 Hours**

Introduction to Fourier Series, Representation of DT signal by Fourier Transform (FT), Properties of FT: Linearity, periodicity, time shifting, frequency shifting, time reversal, differentiation, convolution theorem, windowing theorem Discrete Fourier Transform (DFT), DFT and FT, IDFT, Twiddle factor, DFT as linear transformation matrix, Properties of DFT, circular shifting, Circular Convolution, DFT as Linear filtering, overlap save and add, DFT spectral leakage.

Unit III	**Fast Fourier Transform (FFT) and Z-Transform (ZT)**	**08 Hours**

Effective computation of DFT, Radix-2 FFT algorithms: DIT FFT, DIF FFT, Inverse DFT using FFT, Z-transform (ZT), ZT and FT, ZT and DFT, ROC and its properties, ZT Properties, convolution, initial value theorem, Rational ZT, Pole Zero Plot, Behavior of causal DT signals, Inverse Z Transform (IZT): power series method, partial fraction expansion (PFE) , Residue method.

Unit IV	Analysis of DT - LTI Systems	08 Hours

System function H(z), H(z) in terms of Nth order general difference equation, all poll and all zero systems, Analysis of LTI system using H(Z), Unilateral Z-transform: solution of difference equation, Impulse and Step response from difference equation, Pole zero plot of H(Z) and difference equation, Frequency response of system, Frequency response from pole-zero plot using simple geometric construction.

Unit V	Digital Filter Design	08 Hours

Concept of filtering, Ideal filters and approximations, specifications, FIR and IIR filters, Linear phase response, FIR filter Design: Fourier Series method, Windowing method, Gibbs Phenomenon, desirable features of windows, Different window sequences and its analysis, Design examples IIR filter design: Introduction, Mapping of S-plane to Z-plane, Impulse Invariance method, Bilinear Z transformation (BLT) method, Frequency Warping, Pre-warping, Design examples, Comparison of IIR and FIR Filters.

Unit VI	Filter Structures and DSP Processors	08 Hours

Filter Structures for FIR Systems: direct form, cascade form, structures for linear phase FIR Systems, Examples, Filter structures for IIR Systems: direct form, cascade form, parallel form, Examples DSP Processors: ADSP 21XX Features, comparison with conventional processor, Basic Functional Block diagram, SHARC DSP Processor Introduction to OMAP (Open Multimedia Application Platform).

Books:

Text:
1. Proakis J, Manolakis D, "Digital Signal Processing", 4th Edition, Pearson Education, ISBN 9788131710005
2. Oppenheium A, Schafer R, Buck J, "Discrete time Signal Processing", 2nd Edition, Pearson Education, ISBN 9788131704929

Reference:
1. Mitra S., "Digital Signal Processing: A Computer Based Approach", Tata McGraw-Hill, 1998, ISBN 0-07-044705-5
2. Ifleachor E. C., Jervis B. W., "Digital Signal Processing: A Practical Approach ", Pearson-Education, 2002, , ISBN-13: 978-0201596199,ISBN-10: 0201596199
3. S. Salivahanan, A. Vallavaraj, C. Gnanapriya, "Digital Signal Processing", McGraw-Hill, ISBN 0-07-463996-X
4. S. Poornachandra, B. Sasikala, "Digital Signal Processing",3rd Edition, McGraw-Hill, ISBN-13:978-07- 067279-6
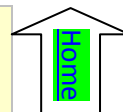
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Fourth Year of Computer Engineering (2015 Course)

Elective I

410244(B): Software Architecture and Design

Teaching Scheme: TH: 03 Hours/Week	Credit 03	Examination Scheme: In-Sem (Paper): 30 Marks End-Sem (Paper): 70 Marks

Prerequisite Courses: 310243- Software Engineering and Project Management

Companion Course: 410247-Laboratory Practice II

Course Objectives:

- To introduce basic concepts and principles about software design and software architecture
- To learn practical approaches and methods for creating and analyzing software architecture
- To acquaint with the interaction between quality attributes and software architecture
- To experience with examples in design pattern application and case studies in software architecture
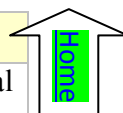
Course Outcomes:

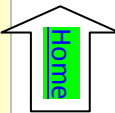On completion of the course, student will be able to–

- Express the analysis and design of an application
- Specify functional semantics of an application
- Evaluate software architectures
- Select and use appropriate architectural styles and software design patterns

Course Contents

Unit I	Introduction	08 Hours

Introduction to Software Architecture, Architecture Business Cycle- Where do architecture come from, Software processes and the Architecture Business cycle, What makes Good Architecture. What is software architecture- What Software Architecture is and what it is not, Other points of View, Architectural Patterns, Reference Models, Reference Architectures, Why is Software Architecture important, Architectural structure and Views. Case Study-A-7E Avionics System.

Unit II	Quality Attributes	08 Hours

Introduction to Quality Attributes, Understanding quality attributes- Functionality and Architecture, architecture and quality attributes, System Quality Attributes, Quality Attribute Scenario in Practice, Other System Quality Attributes, Business Qualities, and Architecture Qualities. Achieving quality attributes- Introducing Tactics, Availability tactics, Modifiability tactics, Performance tactics, Security tactics, Testability tactics, Usability tactics, Relationship of tactics to Architectural patterns, Architectural Patterns and Styles. Case study- Air Traffic Control.

Unit III	Designing the Architectures and Introduction to Design Patterns	08 Hours

Architecture in Life Cycle, Designing the Architecture, Forming the team structure, Creating a skeletal system, Case Study- Flight Simulation. Design Patterns: What is Design Pattern?, Describing Design Patterns, The Catalog of Design Patterns, Organizing the Catalog, How Design patterns solves design problems, How to select Design Patterns, How to use Design Patterns.

Unit IV	Design Pattern Catalog	08 Hours

Creational Patterns- Abstract Factory, Singleton. Structural Patterns- Adaptor, Facade, Proxy. Behavioral Patterns- Chain of Responsibility, Iterator, Mediator, Observer. What to expect from Design Patterns.

Unit V	Client Side Technologies	08 Hours

Introduction to three tier and n-Tier Web Architectures, Need of Client side technology in multi-tier architectures, XML, Client side technologies- HTML, DHTML, Java Applets, Active X controls, DOM, AJAX. Case study-Mobile or portable client side technologies.

Unit VI	Middleware and Server Side Technologies	08 Hours

Introduction to Middleware, Types of Middleware, Application servers, Introduction to Java EE, Introduction to Java EE technologies like JMS, JDBC, RPC, RMI, SOCKET. EJB 3.0 Architecture, Entity, Session, Message beans, XML, XSLT. Specifications and characteristics of Middleware technologies. Server Side Technologies- Need of server side technology in multi-tier architectures, Java Web Services, Server side technologies: JSP, JSF, SOA, MVC. Java Servlets, struts.

Books:

Text:

1. Len Bass, Paul Clements, Rick Kazman, "Software Architecture in Practice", Second Edition, Pearson ,ISBN 978-81-775-8996-2
2. Erich Gamma, "Design Patterns", Pearson, ISBN 0-201-63361-*2*.
3. Kogent, "Java Server Programming Black Book", Dream Tech Press, PHI Publications, ISBN: 978-81-7722-835-9.

References:

1. James L. Weaver, Kevin Mukhar, "Beginning J2EE 1 .4: From Novice to Professional", ISBN-10: 1590593413, ISBN-13: 978-1590593417
2. Richard N.Taylor , Nenad M., "Software Architecture Foundation Theory and practice", Wiley ISBN: 978-81-265-2802-8.
3. Java6 Programming, Black Book DreamTech Press, ISBN:978-81-7722-736-9

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Savitribai Phule Pune University
Fourth Year of Computer Engineering (2015 Course)
Elective I
410244(C): Pervasive and Ubiquitous Computing

Teaching Scheme: TH: 03 Hours/Week	Credit 03	Examination Scheme: In-Sem (Paper): 30 Marks End-Sem (Paper): 70 Marks

Prerequisite Courses: 310245- Computer Networks

Companion Course: 410247-Laboratory Practice II

Course Objectives:
- To understand the characteristics and principles of Pervasive computing
- To introduce to the enabling technologies of pervasive computing
- To understand the basic issues and performance requirements of pervasive computing applications
- To learn the trends of pervasive computing

Course Outcomes:
On completion of the course, student will be able to–
- Design and implement primitive pervasive applications
- Analyze and estimate the impact of pervasive computing on future computing applications and society
- Develop skill sets to propose solutions for problems related to pervasive computing system
- Design a preliminary system to meet desired needs within the constraints of a particular problem space

Course Contents		
Unit I	**Pervasive Computing**	**08 Hours**

Pervasive Computing, Applications, Pervasive Computing devices and Interfaces, Device technology trends, Connecting issues and protocols. Pervasive Computing- Principles, Characteristics, interaction transparency, context aware, automated experience capture. Architecture for pervasive computing.

Unit II	**Open Protocols**	**08 Hours**

Open protocols, Service discovery technologies- SDP, Jini, SLP, UpnP protocols, data Synchronization, SyncML framework, Context aware mobile services, Context aware sensor networks, addressing and communications- Context aware security. Pervasive Computing and web based Applications - XML and its role in Pervasive Computing, Wireless Application Protocol (WAP) Architecture and Security, Wireless Mark-Up language (WML) – Introduction. Moving on from Weiser's Vision of Calm Computing: Engaging UbiComp Experiences.

Unit III	**Voice Enabled Pervasive Computing**	**08 Hours**

Voice Enabled Pervasive Computing, Voice Standards, Speech Applications in Pervasive Computing and security. Device Connectivity, Web application Concepts, WAP and Beyond. Voice Technology – Basis of speech Recognition, Voice Standards, Speech Applications, Speech and Pervasive Computing, Security, The Hitchhiker's Guide to UbiComp: Using techniques from Literary and Critical Theory to Reframe Scientific Agendas.

Unit IV	Personal Digital Assistant	08 Hours

Personal Digital Assistant – History, Device Categories, Device Characteristics, Software Components, Standards. Server side programming in Java, Pervasive Web application Architecture, Example Application, Access via PCs, Access via WAP, Access via PDA,   and Access via Voice, Pinch Watch: A Wearable Device for One-Handed Micro interactions., Interfaces - Enabling mobile micro-interactions with physiological computing.

Unit V	User Interface	08 Hours

User Interface Issues in Pervasive Computing, Architecture, and Smart Card based Authentication Mechanisms, Wearable computing Architecture. Touche: Enhancing Touch Interaction on Humans, Screens, Liquids, and Everyday Objects

Unit VI	Context Awareness and Application Development	08 Hours

Location as context, Location Tracking, Co-ordinate models, Location Data Sources, sorting and search in location data. Sensing Activity based on various wearable sensors, smart phone sensors. Wearable Computing applications in Healthcare and Assistive Technologies. Developing, Deploying and Evaluating Pervasive computing applications. Application in Augmented Reality.

Books:

Text:
1. Jochen Burkhardt, Horst Henn, Stefan Hepper, Thomas Schaec and Klaus Rindtorff, "Pervasive Computing Technology and Architecture of Mobile Internet Applications", Addision Wesley, 2002. ISBN:13: 978-0-201-72215-4
2. Uwe Hansman, Lothat Merk, Martin S Nicklous and Thomas Stober: "Principles of Mobile Computing", Second Edition, Springer- Verlag, New Delhi, 2003, ISBN: 9783662043189

References:
1. Mohammads, Obaidait, Denko, Woungang, "Pervasive Computing and Networking", Wiley, ISBN:978-0-470-74772-8
2. Seng Loke, "Context-Aware Computing Pervasive Systems", Auerbach Pub., New York, 2007, ISBN: 978-1-4471-5006-0
3. Uwe Hansmann etl, "Pervasive Computing", Springer, New York,2001., ISBN: 10: 3540002189
4. John Krumm, "Ubiquitous Computing Fundamentals", Shroff Publishers, ISBN: 9781420093605
5. Adelstein, "Fundamental of Mobile and Pervasive Computing", McGrawHill, ISBN: 0-07-141237-9

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Savitribai Phule Pune University
Fourth Year of Computer Engineering (2015 Course)
Elective I
410244(D): Data Mining and Warehousing

Teaching Scheme: TH: 03 Hours/Week	Credit 03	Examination Scheme: In-Sem (Paper): 30 Marks End-Sem (Paper): 70 Marks

Prerequisite Courses: 310242-Database Management Systems, 310244- Information Systems and Engineering Economics

Companion Course: 410247-Laboratory Practice II

Course Objectives:

- 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:

On completion of the course the student should be able to-

- Apply basic, intermediate and advanced techniques to mine the data
- Analyze the output generated by the process of data mining
- Explore the hidden patterns in the data
- Optimize the mining process by choosing best data mining technique

Course Contents		
Unit I	**Introduction**	**08 Hours**
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		
Unit II	**Data Warehouse**	**08 Hours**
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.		
Unit III	**Measuring Data Similarity and Dissimilarity**	**08 Hours**

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.

Unit IV	Association Rules Mining	08 Hours

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.

Unit V	Classification	08 Hours

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.

Unit VI	Multiclass Classification	08 Hours

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.

Books:

Text:
1. Han, Jiawei Kamber, Micheline Pei and Jian, "Data Mining: Concepts and Techniques", Elsevier Publishers, ISBN:9780123814791, 9780123814807.
2. Parag Kulkarni, "Reinforcement and Systemic Machine Learning for Decision Making" by Wiley-IEEE Press, ISBN: 978-0-470-91999-6

References:
1. Matthew A. Russell, "Mining the Social Web: Data Mining Facebook, Twitter, LinkedIn, Google+, GitHub, and More" , Shroff Publishers, 2nd Edition, ISBN: 9780596006068
2. Maksim Tsvetovat, Alexander Kouznetsov, "Social Network Analysis for Startups:Finding connections on the social web", Shroff Publishers , ISBN: 10: 1449306462
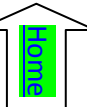
Savitribai Phule Pune University
Fourth Year of Computer Engineering (2015 Course)
Elective II
410245(A): Distributed Systems

Teaching Scheme: TH: 03 Hours/Week	Credit 03	Examination Scheme: In-Sem (Paper): 30 Marks End-Sem (Paper): 70 Marks

Prerequisite Courses: 310245-Computer Networks, 310254-Web Technology, 210254-Principles of Programming Languages

Companion Course: 410247-Laboratory Practice II

Course Objectives:
- To understand the concept of Distributed system, remote method invocation and Remote Procedure Calls.
- To learn communication methodology in distributed systems.
- To acquaint with the Distributed File Systems.
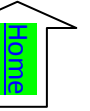- To know the concepts of shared memory and security aspects in distributed system.

Course Outcomes:

On completion of the course, student will be able to–
- Able to learn and apply the concept of remote method invocation and Remote Procedure Calls
- Able to analyze the mechanism of peer to peer systems and Distributed File Systems
- Demonstrate an understanding of the challenges faced by current and future distributed systems

Course Contents

Unit I	Introduction	08 Hours

Characteristics of Distributed Systems(DS): Introduction, Examples of DS, Trends in DS, Sharing Resources, Challenges in DS. System Models: Physical, Architectural and Fundamental Models Remote Invocation : Request Reply protocols, RPC, RMI, Case Study- JAVA RMI.

Unit II	Distributed Algorithms	08 Hours

Representing Distributed Algorithms: Representation Guarded Actions, Non-determinism, Atomic actions, Fairness, Central vs Distributed Scheduler. Time in Distributed Systems: Logical clocks, Vector clocks, Physical Clock Synchronization, Algorithms for Internal and External Clock Synchronization. Mutual Exclusion: Solution to Message passing systems, Token-Passing algorithms, Solutions on shared memory models, Mutual exclusion using special instructions, Group mutual exclusion.

Unit III	Distributed Snapshot	08 Hours

Distributed Snapshot: Properties of Consistent snapshot, Chandy-Lamport algorithm, Lai-Yang algorithm, Distributed debugging. Global state collection : Elementary algorithm for All-to- All broadcasting, Termination Detection algorithm, Wave algorithm, Distributed deadlock detection Coordination Algorithms: Leader Elections, Algorithms like Bully, Maxima finding on the ring, election in arbitrary networks, Election in anonymous networks. Synchronizers: ABD synchronizer, Awerbuch's synchronizers.

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Unit IV	Distributed Consensus	08 Hours

Distributed consensus: Consensus in asynchronous systems, Consensus in synchronous systems, Paxo's algorithm, Failure detectors. Distributed Transactions: Classification of transactions, Implementing Transactions, Concurrency control and serializability, Atomic Commit protocols, Recovery from Failures.

Unit V	Group Communication	08 Hours

Group Communication: Atomic multicast, IP Multicast, Application layer multicast, Ordered multicast, Reliable multicast, Open groups. Replicated Data Management: Architecture of replicated Data Management, Data-Centric Consistency models, Client centric consistency protocols, Implementation of Data-Centric Consistency models, Quorum based protocols, Replica Placement, Brewer's CAP algorithm.

Unit VI	Distributed Discrete-Event Simulation	08 Hours

Distributed Discrete-Event Simulation: Distributed simulation, Conservative Simulation, Optimistic simulation and Time warp. Security in DS: Security Mechanisms to thwart various attacks in DS. Social and Peer-to-Peer network: Metrics of Social networks, Modeling Social Networks, Centrality measure in Social network, Community detection, Koorde and De Brujin Graphs, Skip graph, Replication management, Bit-torrent and free riding, Censorship resistance and anonymity.

Books:

Text:
1. George Coulouris, Jean Dollimore and Tim Kindberg, "Distributed Systems, Concepts and Design", Fifth Edition, Addison Wesley, ISBN 0-13-214301-1.
2. Sukumar Ghosh, "Distribute Systems : An Algorithmic Approach", Chapman and Hall, CRC Press, Second Edition, 2015, ISBN 10: 1584885645 ISBN 13: 9781584885641
3. Andrew S. Tanenbaum and Maarten van Steen, "Distributed Systems –Principles and Paradigms" , PHI Publication, ISBN 0-13-239227-5

References:
1. Shvartsman, A.A., Weatherspoon, H.; Zhao, "Future Directions in Distributed Computing Research and Position Papers Series: Lecture Notes in Computer Science" , Vol. 2584 Schiper, (Eds.) 2003, X, 219 p., ISBN: 978-3-540- 00912-2
2. Sape Mullender, "Distributed Systems", (Editor),Addison-Wesley Publication, I*SBN* 10: 0201624273 - ISBN13: 9780201624274
3. Kenneth, P. Birman, "Reliable Distributed Systems: Technologies, Web Services, and Applications", Springer; 1 edition, ISBN-10: 0387215093; ISBN-13: 978-0387215099
4. Galli D.L., "Distributed Operating Systems: Concepts and Practice", Prentice-Hall 2000, ISBN0-13-079843-6

Savitribai Phule Pune University
Fourth Year of Computer Engineering (2015 Course)
Elective II
410245(B): Software Testing and Quality Assurance

Teaching Scheme: TH: 03 Hours/Week	Credit 03	Examination Scheme: In-Sem (Paper): 30 Marks End-Sem (Paper): 70 Marks

Prerequisite Courses: 310243- Software Engineering and Project Management,310263- Software Modeling and Design

Companion Course: 410247-Laboratory Practice II

Course Objectives:
- 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
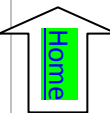- Understand the importance of software quality and assurance software systems development.

Course Outcomes:
On completion of the course, student will be able to–
- Describe fundamental concepts in software testing such as manual testing, automation testing and software quality assurance.
- Design and develop project test plan, design test cases, test data, and conduct test operations
- Apply recent automation tool for various software testing for testing software
- Apply different approaches of quality management, assurance, and quality standard to software system
- Apply and analyze effectiveness Software Quality Tools

Course Contents		
Unit I	**Introduction**	**08 Hours**

Introduction, historical perspective, Definition, Core Components, Quality View, Financial Aspect, Customers suppliers and process, Total Quality Management(TQM), Quality practices of TQM, Quality Management through- Statistical process Control, Cultural Changes, Continual Improvement cycle, quality in different areas, Benchmarking and metrics, Problem Solving Techniques, Problem Solving Software Tools.

Software Quality- Introduction, Constraints of Software product Quality assessment, Customer is a King, Quality and Productivity Relationship, Requirements of Product, Organization Culture, Characteristics of Software, Software Development Process, Types of Product, Criticality Definitions, Problematic areas of SDLC, Software Quality Management, Why Software has defects, Processes related to Software Quality, Quality Management System's Structure, Pillars of Quality Management System, Important aspects of quality management.

Unit II	**Test Planning and Management**	**08 Hours**

Review of Fundamentals of Software Testing, Testing during development life cycle, Requirement Traceability matrix, essentials, Work bench, Important Features of Testing Process, Misconceptions, Principles, salient and policy of Software testing, Test Strategy, Test Planning, Testing Process and number of defects found, Test teem efficiency, Mutation testing, challenges, test team approach, Process problem faced, Cost aspect, establishing testing policy, methods, structured approach, categories of defect, Defect/ error/ mistake in software, Developing Test Strategy and Plan, Testing process, Attitude towards testing, approaches, challenges, Raising management awareness for testing, skills required by tester.

Unit III	Software Test Automation	08 Hours

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 for Test Tool, Process Model for Automation, Selecting Test Tool, Automation for XP/Agile model, Challenges in Automation, Data-driven Testing. Automation Tools like JUnit, Jmeter

Unit IV	Selenium Tool	08 Hours

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

Unit V	Quality Management	08 Hours

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.

Unit VI	Software Quality Tools	08 Hours

Total Quality Management, Product Quality Metrics, In process Quality Metrics, Software maintenance, 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.

Books:

Text:
1. M G Limaye, "Software Testing Principles, Techniques and Tools", Tata McGraw Hill, ISBN: 9780070139909 0070139903
2. Srinivasan Desikan, Gopalswamy Ramesh, "Software Testing Principles and Practices", Pearson, ISBN-10: 817758121X

References:
1. Naresh Chauhan, "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
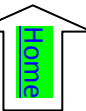
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Savitribai Phule Pune University
Fourth Year of Computer Engineering (2015 Course)
Elective II
410245(C): Operations Research

Teaching Scheme: TH: 03 Hours/Week	Credit 03	Examination Scheme: In-Sem (Paper): 30 Marks End-Sem (Paper): 70 Marks

Prerequisite Courses: 210241- Discrete Mathematics, 310243- Software Engineering and Project Management

Companion Course: 410247-Laboratory Practice II

Course Objectives:

- To introduce the learners the quantitative methods and techniques for effective analysis of decisions making
- To understand the model formulation and applications that is used in solving business decision problems.
- To introduce the optimization approaches and fundamental solution.
- To learn a variety of ways in which deterministic and stochastic models in Operations Research can be used

Course Outcomes:

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

- Identify the characteristics of different types of decision-making environments
- Use appropriate decision making approaches and tools
- Build various dynamic and adaptive models
- Develop critical thinking and objective analysis of decision problems
- Apply the OR techniques for efficacy

Course Contents		
Unit I	**Linear Programming**	**08 Hours**
Introduction, Modeling with Liner Programming, Two variable LP model, Graphical LP solutions for both maximization and minimization models with various application examples, LP model in equation form, simplex method, special case in simplex method, artificial starting solution, Degeneracy in LPP, Unbounded and Infeasible solutions.		
Unit II	**Duality in Linear Programming and Revised Simplex Method**	**08 Hours**
Duality theory: a fundamental insight. The essence of duality theory, Economic interpretation of duality, Primal dual relationship; Adapting to other primal forms, The revised simplex method- development of optimality and feasibility conditions, Revised Simplex Algorithms.		
Unit III	**The Transportation Problem and Assignment Problem**	**08 Hours**

Finding an initial feasible solution - North West-corner method, Least cost method, Vogel's Approximation method, Finding the optimal solution, optimal solution by stepping stone and MODI methods, Special cases in Transportation problems - Unbalanced Transportation problem. Assignment Problem: Hungarian method of Assignment problem, Maximization in Assignment problem, unbalanced problem, problems with restrictions, travelling salesman problems.

Unit IV	**Game Theory and Dynamic Programming**	**08 Hours**

Introduction, 2 person zero sum games, Minimax, Maximin principle, Principle of Dominance, Solution for mixed strategy problems, Graphical method for 2 x n and m x 2 games. Recursive nature of computations in Dynamic Programming, Forward and backward recursion, Dynamic Programming Applications – Knapsack, Equipment replacement, Investment models

Unit V	**Integer Programming Problem and Project Management**	**08 Hours**

Integer Programming Algorithms – BandB Algorithms, cutting plane algorithm, Gomory's All-IPP Method, Project Management: Rules for drawing the network diagram, Application of CPM and PERT techniques in project planning and control; Crashing and resource leveling of operations Simulation and its uses in Queuing theory and Materials Management

Unit VI	**Decision Theory and Sensitivity Analysis**	**08 Hours**

Decision making under certainty, uncertainty and risk, sensitivity analysis, Goal programming formulation and algorithms – The weights method, The preemptive method

Books:

Text:
1. Hamdy A. Taha, "Operations Research" , Pearson Education, 8th Edition, ISBN: 978-81-317-1104-0
2. Gillett, "Introduction to Operations Research", TMH, ISBN: 0070232458

References:
1. S.D. Sharma, Kedarnath, Ramnath and Co, "Operations Research", 2009, ISBN:978-81-224-2288-7
2. Hrvey M. Wagner, "Principles of Operations Research", Second Edition, Prentice Hall of India Ltd., 1980, ISBN: 10: 0137095767, 13: 9780137095766..
3. V.K. Kapoor, "Operations Research", S. Chand Publishers, New Delhi, 2004, ISBN: 9788180548543, 8180548546.
4. R. Paneer Selvam, "Operations Research", Second Edition, PHI Learning Pvt. Ltd., New Delhi, 2008, ISBN: 10: 8120329287,: 9788120329287.

Savitribai Phule Pune University
Fourth Year of Computer Engineering (2015 Course)
Elective II
410245(D): Mobile Communication

Teaching Scheme: TH: 03 Hours/Week	Credit 03	Examination Scheme: In-Sem (Paper): 30 Marks End-Sem (Paper): 70 Marks

Prerequisite Courses: 310245-Computer Networks

Companion Course: 410247-Laboratory Practice II

Course Objectives:
- To understand the Personal Communication Services
- To learn the design parameters for setting up mobile network
- To know GSM architecture and support services
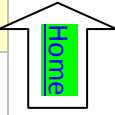- To learn current technologies being used on field

Course Outcomes:

On completion of the course, student will be able to–
- Justify the Mobile Network performance parameters and design decisions.
- Choose the modulation technique for setting up mobile network.
- Formulate GSM/CDMA mobile network layout considering futuristic requirements which conforms to the technology.
- Use the 3G/4G technology based network with bandwidth capacity planning.
- Percept to the requirements of next generation mobile network and mobile applications.

Course Contents		
Unit I	**Introduction to Cellular Networks**	**08 Hours**

Cell phone generation-1G to 5G, Personal Communication System (PCS), PCS Architecture, Mobile Station,, SIM, Base Station, Base Station Controller, Mobile Switching Center, MSC Gateways, HLR and VLR, AuC/EIR/OSS, Radio Spectrum, Free Space Path Loss, S/N Ratio, Line of sight transmission, Length of Antenna, Fading in Mobile Environment.

Unit II	**Cellular Network Design**	**08 Hours**

Performance Criterion, Handoff/Hanover, Frequency Reuse, Co-channel Interference and System Capacity, Channel Planning, Cell Splitting, Mobility Management in GSM and CDMA.

Unit III	**Medium Access Control**	**08 Hours**

Specialized MAC, SDMA, FDMA, TDMA, CDMA, Frequency Hopping Spread Spectrum (FHSS), Direct Sequence Spread Spectrum (DSSS), GMSK Modulation, 8PSK, 64 QAM, 128 QAM and OFDM

Unit IV	**GSM**	**08 Hours**

GSM – Architecture, GSM Identifiers, Spectrum allocation, Physical and Logical Traffic and Control channels, GSM Bursts, GSM Frame, GSM Speech Encoding and decoding, Location Update, Incoming and Outgoing Call setup, GPRS.

Unit V	Current 3G and 4G Technologies for GSM and CDMA	08 Hours

EDGE, W-CDMA: Wideband CDMA, CDMA2000, UMTS, HSPA (High Speed Packet Access), HSDPA, HSUPA, HSPA+, LTE (E-UTRA) 3GPP2 family CDMA2000 1x, 1xRTT, EV-DO (Evolution-Data Optimized), Long Term Evolution (LTE) in 4G.

Unit VI	Advances in Mobile Technologies	08 Hours

5GAA (Autonomous Automation), Millimetre Wave, URLLC, LTEA (Advanced), LTE based MULTIFIRE, Virtual Reality, Augmented Reality.

Books:

Text:

1. Jochen Schiller, "Mobile Communications", Pearson Education, Second Edition, 2004, ISBN: 13: 978-8131724262

2. Jason Yi-Bing Lin, Yi-Bing Lin, Imrich Chlamtac, "Wireless and Mobile network Architecture", 2005, Wiley Publication, ISBN: 978812651560

3. Martin Sauter, "3G, 4G and Beyond: Bringing Networks, Devices and the Web Together", 2012, ISBN-13: 978-1118341483

References:

1. Theodore S Rappaport, "Wireless Communications – Principles and Practice" , Pearson Education India, Second Edition, 2010, ISBN: 978-81-317-3186-4

2. Lee and Kappal, "Mobile Communication Engineering", Mc Graw Hill, ISBN:

3. William Stallings, "Wireless Communication and Networks", Prentice Hall, Second Edition, 2014, ISBN: 978-0131918351
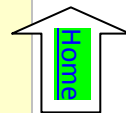
Savitribai Phule Pune University
Fourth Year of Computer Engineering (2015 Course)
410246:Laboratory Practice I

Teaching Scheme: Practical : 04 Hours/Week	Credit 02	Examination Scheme: Term Work: 50 Marks Practical: 50 Marks

Companion Courses: 410241, 410242 and 410243

Course Objectives and Outcomes: Practical hands on is the absolute necessity as far as employability of the learner is concerned. The presented course is solely intended to enhance the competency by undertaking the laboratory assignments of the core courses.

About

Laboratory Practice I is for practical hands on for core courses High Performance Computing, AI & Robotics, and Data Analytics.

Guidelines for Laboratory Conduction

- **List of recommended programming assignments and sample mini-projects is provided for reference.**
- Referring these, Course Teacher or Lab Instructor may frame the assignments/mini-project by understanding the prerequisites, technological aspects, utility and recent trends related to the respective courses.
- Preferably there should be multiple sets of assignments/mini-project and distribute among batches of students.
- Real world problems/application based assignments/mini-projects create interest among learners serving as foundation for future research or startup of business projects.
- Mini-project can be completed in group of 2 to 3 students.
- Software Engineering approach with proper documentation is to be strictly followed.
- Use of open source software is to be encouraged.
- Instructor may also set one assignment or mini-project that is suitable to respective course beyond the scope of syllabus.

Operating System recommended :-   64-bit Open source Linux or its derivative

Programming Languages: C++/JAVA/PYTHON/R

Programming tools recommended: Front End: Java/Perl/PHP/Python/Ruby/.net, Backend : MongoDB/MYSQL/Oracle, Database Connectivity : ODBC/JDBC, Additional Tools: Octave, Matlab, WEKA**.**

Guidelines for Student Journal

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

As a conscious effort and little contribution towards Green IT and environment awareness, attaching printed papers as part of write-ups and program listing to journal may be avoided. Use of digital storage media/DVD containing students programs maintained by lab In-charge is highly encouraged. For reference one or two journals may be maintained with program prints at Laboratory.

Guidelines for Assessment

Continuous assessment of laboratory work is to be 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 **reserving weightage for successful mini-project completion and related documentation.**

Guidelines for Practical Examination

- Both internal and external examiners should jointly frame suitable problem statements for practical examination based on the term work completed.
- During practical assessment, the expert evaluator should give the maximum weightage to the satisfactory implementation of the problem statement.
- The supplementary and relevant questions may be asked at the time of evaluation to test the student's for advanced learning, understanding of the fundamentals, effective and efficient implementation.
- Encouraging efforts, transparent evaluation and fair approach of the evaluator will not create any uncertainty or doubt in the minds of the students. So adhering to these principles will consummate our team efforts to the promising boost to the student's academics.

Guidelines for Instructor's Manual

The instructor's manual is to be developed as a hands-on resource and as ready reference. The instructor's manual need to include prologue (about University/program/ institute/ department/foreword/ preface etc), University syllabus, conduction and Assessment guidelines, topics under consideration-concept, objectives, outcomes, set of typical applications/assignments/ guidelines, references among others.

Suggested List of Laboratory Assignments & Mini Projects

(any 04 assignments per High Performance Computing, AI, and Data Analytics and Mini-project per course)

410241:: High Performance Computing

Note: for all programming assignments of HPC-
- Select the suitable model of a parallel computation (Data parallel model, Task graph model, Work pool model, Master slave model , Producer consumer or pipeline model, Hybrid model or other) for algorithm to be developed by considering a strategy for dividing the data, processing method and suitable strategy to reduce interactions.
- Assume suitable processor model, topology, load distribution strategy and Communication.
- Utilize all available resources.
- Test on data set of sufficiently large size
- Compute Total cost and Efficiency as
  Total Cost = Time complexity × Number of processors used
   Efficiency =   WCSA/ WCPA
  (WCSA--Worst case execution time of sequential algorithm and   WCPA--Worst case execution time of the parallel algorithm)
- Compare performance by varying number of processors used and also with sequential algorithm.

1.	a) Implement Parallel Reduction using Min, Max, Sum and Average operations.
	b) Write a CUDA program that, given an N-element vector, find-
	• The maximum element in the vector
	• The minimum element in the vector

|	
5.	• The arithmetic mean of the vector • The standard deviation of the values in the vector Test for input N and generate a randomized vector V of length N (N should be large). The program should generate output as the two computed maximum values as well as the time taken to find each value.

2.	**Vector and Matrix Operations-**
	Design parallel algorithm to
	      1. Add two large vectors
	      2. Multiply Vector and Matrix
	      3. Multiply two N × N arrays using n^2 processors

3.	**Parallel Sorting Algorithms-** For Bubble Sort and Merger Sort, based on existing sequential algorithms, design and implement parallel algorithm utilizing all resources available.
4.	**Parallel Search Algorithm-** Design and implement parallel algorithm utilizing all resources available. for • **Binary Search for Sorted Array** • **Depth-First Search (** tree or an undirected graph) **OR** • **Breadth-First Search (** tree or an undirected graph) **OR** • **Best-First Search that (** traversal of graph to reach a target in the shortest possible path)
5.	Parallel Implementation of the K Nearest Neighbors Classifier
	Sample Mini Projects
6.	**Compression Module (Image /Video)** Large amount of bandwidth is required for transmission or storage of images. This has driven the research area of image compression to develop parallel algorithms that compress images. **OR** For video: RGB To YUV Transform concurrently on many core GPU
7.	**Generic Compression** Run length encoding concurrently on many core GPU
8.	**Encoding** Huffman encoding concurrently on many core GPU
9.	**Database Query Optimization** Long running database Query processing in parallel
	410242: Artificial Intelligence and Robotics
1.	Implement Tic-Tac-Toe using A* algorithm
2.	Implement 3 missionaries and 3 cannibals problem depicting appropriate graph. Use A* algorithm.
3.	Solve 8-puzzle problem using A* algorithm. Assume any initial configuration and define goal configuration clearly.
4.	Define the operators for controlling domestic robot; use these operators to plan an activity to be executed by the robot. For example, transferring two/three objects one over the other from one place to another. Use Means-Ends analysis with all the steps revealed.
5.	Implement any one of the following Expert System , • Medical Diagnosis of 10 diseases based on adequate symptoms

	• Identifying birds of India based on characteristics
6.	Implement alpha-beta pruning graphically with proper example and justify the pruning.
7.	Develop elementary chatbot for suggesting investment as per the customers need.
8.	Solve following 6-tiles problem stepwise using A* algorithm,

Initial Configuration

B	W	B	W	B	W	

Final Configuration

B	B	B	W	W	W	

Constraint: Tiles can be shifted left or right 1 or 2 positions with cost 1 and 2 respectively.

9.	Implement goal stack planning for the following configurations from the blocks world,

Start   Goal

10.	Use Heuristic Search Techniques to Implement Hill-Climbing Algorithm.
11.	Use Heuristic Search Techniques to Implement Best first search (Best-Solution but not always optimal) and A* algorithm (Always gives optimal solution).
12.	Constraint Satisfaction Problem: Implement crypt-arithmetic problem or n-queens or graph coloring problem (Branch and Bound and Backtracking)
13.	Implement syntax analysis for the assertive English statements. The stages to be executed are, • Sentence segmentation • Word tokenization • Part-of-speech/morpho syntactic tagging • Syntactic parsing (Use any of the parser like Stanford)
14.	Mini Projects based on Robotics..

410243:: Data Analytics

1.	Download the Iris flower dataset or any other dataset into a DataFrame. (eg https://archive.ics.uci.edu/ml/datasets/Iris) Use Python/R and Perform following – • How many features are there and what are their types (e.g., numeric, nominal)? • Compute and display summary statistics for each feature available in the dataset. (eg. minimum value, maximum value, mean, range, standard deviation, variance and percentiles • Data Visualization-Create a histogram for each feature in the dataset to illustrate the feature distributions. Plot each histogram. • Create a boxplot for each feature in the dataset. All of the boxplots should be combined into a single plot. Compare distributions and identify outliers.
2.	Download Pima Indians Diabetes dataset. Use Naive Bayes' Algorithm for classification • Load the data from CSV file and split it into training and test datasets. • summarize the properties in the training dataset so that we can calculate probabilities and make predictions. • Classify samples from a test dataset and a summarized training dataset.
3.	Write a Hadoop program that counts the number of occurrences of each word in a text file.
4.	Write a program that interacts with the weather database. Find the day and the station with the maximum snowfall in 2013.
5.	Use Movies Dataset. Write the map and reduce methods to determine the average ratings of

	movies. The input consists of a series of lines, each containing a movie number, user number, rating, and a timestamp: The map should emit movie number and list of rating, and reduce should return for each movie number a list of average rating.
6.	Trip History Analysis: Use trip history dataset that is from a bike sharing service in the United States. The data is provided quarter-wise from 2010 (Q4) onwards. Each file has 7 columns. Predict the class of user. Sample Test data set available here https://www.capitalbikeshare.com/trip-history-data
7.	Bigmart Sales Analysis: For data comprising of transaction records of a sales store. The data has 8523 rows of 12 variables. **Predict the sales of a store.** Sample Test data set available here https://datahack.analyticsvidhya.com/contest/practice-problem-big-mart-sales-iii/
8.	Twitter Data Analysis: **Use** Twitter data for sentiment analysis. The dataset is 3MB in size and has 31,962 tweets. **Identify the tweets which are hate tweets and which are not. S**ample Test data set available here https://datahack.analyticsvidhya.com/contest/practice-problem-twitter-sentiment-analysis/
9.	Time Series Analysis: Use time series and forecast traffic on a mode of transportation. Sample Test data set available here https://datahack.analyticsvidhya.com/contest/practice-problem-time-series-2/
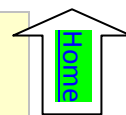
Savitribai Phule Pune University
Fourth Year of Computer Engineering (2015 Course)
410247:Laboratory Practice II

Teaching Scheme: Practical : 04 Hours/Week	Credit 02	Examination Scheme: Term Work: 50 Marks Presentation: 50 Marks

Companion Courses: 410244 and 410245

Course Objectives and Outcomes: Practical hands on is the absolute necessity as far as employability of the learner is concerned. The presented course is solely intended to enhance the competency by undertaking the laboratory assignments of the core courses. Enough choice is provided to the learner to choose an elective of one's interest.

Laboratory Practice II is companion lab for elective course I and elective course II.

Guidelines for Laboratory Conduction

- **List of recommended programming assignments and sample mini-projects is provided for reference.**
- Referring these, Course Teacher or Lab Instructor may frame the assignments/mini-project by understanding the prerequisites, technological aspects, utility and recent trends related to the respective courses.
- Preferably there should be multiple sets of assignments/mini-project and distribute among batches of students.
- Real world problems/application based assignments/mini-projects create interest among learners serving as foundation for future research or startup of business projects.
- Mini-project can be completed in group of 2 to 3 students.
- Software Engineering approach with proper documentation is to be strictly followed.
- Use of open source software is to be encouraged.
- Instructor may also set one assignment or mini-project that is suitable to respective course beyond the scope of syllabus.

Operating System recommended :-   64-bit Open source Linux or its derivative
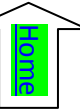
Programming Languages: C++/JAVA/PYTHON/R

Programming tools recommended: Front End: Java/Perl/PHP/Python/Ruby/.net, Backend: MongoDB/MYSQL/Oracle, Database Connectivity : ODBC/JDBC, Additional Tools: Octave, Matlab, WEKA.

Guidelines for Student Journal

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

As a conscious effort and little contribution towards Green IT and environment awareness, attaching printed papers as part of write-ups and program listing to journal may be avoided. Use of digital storage media/DVD containing students programs maintained by lab In-charge is highly encouraged. For reference one or two journals may be maintained with program prints at Laboratory.

Guidelines for Assessment

Home

Continuous assessment of laboratory work is to be 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 **reserving weightage for successful mini-project completion and related documentation.**

Guidelines for Practical Examination

- **It is recommended to conduct examination based on Mini-Project(s) Demonstration and related skill learned.** Team of 2 to 3 students may work on mini-project. During the assessment, the expert evaluator should give the maximum weightage to the satisfactory implementation and software engineering approach followed.
- The supplementary and relevant questions may be asked at the time of evaluation to test the student's for advanced learning, understanding, effective and efficient implementation and demonstration skills.
- Encouraging efforts, transparent evaluation and fair approach of the evaluator will not create any uncertainty or doubt in the minds of the students. So adhering to these principles will consummate our team efforts to the promising start of the student's academics.

Guidelines for Instructor's Manual

The instructor's manual is to be developed as a hands-on resource and as ready reference. The instructor's manual need to include prologue (about University/program/ institute/ department/foreword/ preface etc), University syllabus, conduction and Assessment guidelines, topics under consideration-concept, objectives, outcomes, set of typical applications/assignments/ guidelines, references among others.
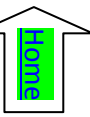
Suggested List of Laboratory Assignments& Mini Projects

Recommended / Sample set of assignments and mini projects for reference for all four courses offered for Elective I and for all four courses offered for Elective II. Respective Student have to complete laboratory work for elective I and II that he/she has opted.

410244: Elective I

410244(A) : Digital Signal Processing

1.	Develop a program to generate samples of sine, Cosine and exponential signals at specified sampling frequency and signal parameters. (Test the results for different analog frequency (F) and sampling frequency (Fs)).
2.	Find the output of a system described by given difference equation and initial conditions for given input sequence. (Solution of difference equation) (Obtain the response for different systems by changing Degree of difference equation (N) and coefficients and also for different input sequence x(n). Observe the response by considering system as FIR and IIR system).
3.	Write a program to plot the magnitude and phase response of a Fourier Transform (FT). (Observe the spectrum for different inputs. Observe the Periodicity).
4.	Find the N point DFT / IDFT of the given sequence x (n). Plot the magnitude spectrum $|X(K)|$ Vs K. (Analyze the output for different N and the same input sequence x(n). Also observe the periodicity and symmetry property).
5.	Find the N point circular convolution of given two sequences. Test it for Linear convolution. Compute the circular convolution of given two sequences using DFT and IDFT.
6.	Develop a program to plot the magnitude and phase response of a given system (given: h(n): impulse response of system S) (Observe the frequency response for different systems.

	Compare the frequency response of a system (filter) for different length h(n) i.e filter coefficients).
7.	**Mini-Project 1:** Design and Develop the N-point radix-2 DIT or DIF FFT algorithm to find DFT or IDFT of given sequence x (n). (Analyze the output for different N. Program should work for any value of N and output should be generated for all intermediate stages.)
8.	**Mini-Project 2:** Obtain the Fourier transform of different window functions to plot the magnitude and phase spectrums. (Window functions: Rectangular, Triangular, Bartlett, Hamming, Henning, Kaiser. Observe and compare the desirable features of window sequences for different length. Observe the main and side lobes).
9.	**Mini-Project 3:** Design an FIR filter from given specifications using windowing method. (Application should work for different types of filter specifications i.e. LPF, HPF, BPF etc and all window sequences. Plot the frequency response for different frequency terms i.e. analog and DT frequency).
10.	**Mini-Project 4:** Design of IIR filter for given specifications using Bilinear Transformation. (Generalized code to accept any filter length for a transfer function H(Z). Application should work for different types of filter specifications that is LPF, HPF, BPF etc. and for different transfer functions of an analog filter).
	410244(B): Software Architecture and Design Patterns
1.	**Mini-Project 1**: Narrate concise System Requirements Specification and organize the problem domain area into broad subject areas and identify the boundaries of problem/system. Identify and categorize the target system services with detailed service specifications modeled with component diagram incorporating appropriate architectural style and coupling. Design the service layers and tiers modeled with deployment diagram accommodating abstraction, autonomy, statelessness and reuse. Map the service levels and primitives to appropriate Strategies for data processing using Client-Server Technologies as applicable.
2.	**Mini-Project 2:** Select a moderately complex system and narrate concise requirement specification for the same. Design the system indicating system elements organizations using applicable architectural styles and design patterns with the help of a detailed Class diagram depicting logical architecture. Specify and document the architecture and design pattern with the help of templates. Implement the system features and judge the benefits of the design patterns accommodated.
	410244(C): Pervasive and Ubiquitous Computing
	Mini-Projects are to be designed so as to use, • No / minimal extra hardware, • uses open source software's, • need hardly any subscription / telephony / data charges.
1.	Design and build a sensing system using micro-controllers like - Arduino / Raspberry Pi / Intel Galileo to sense the environment around them and act accordingly.
2.	Design and build a mobile application with context awareness to determine the remaining battery level depending on the users current usage patterns.
3.	Design and build a music streaming system and a smart mobile application to use the speakers or headphones of the smart phone of multiple phones to stream stored / live music during a party (instead of using large speakers).
4.	Smart Mobile Application with orientation sensing for users to put the phone in meeting / silent mode- OR- outdoor/ loud mode based on the orientation of the device. -OR- Smart Mobile Application with ambient sound / noise sensing to adjust the volume of the phone automatically. -OR- Smart Mobile Application with ambient light sensing to adjust the screen brightness automatically.

5.	**Mini-Project 1:** Smart Mobile Application for Location-Based Messaging Design and build a Location-Based Messaging system where users have commented on various eating joints in the area you currently are. The mobile application should give you inputs / recommendations / suggestions on which eating joints are preferred by whom and for what eating items, with their ratings etc.
6.	**Mini-Project 2:** Smart Mobile Application as a Museum Guide Build a Mobile Application as a museum guide, the device scans the QR codes on the artifacts and gives an interactive detailed explanation using Audio / Text / Video about the museum artifact. using location of the user and the list of previously seen artifacts, the mobile application can suggest / recommend which next artifacts to be seen be the user
7.	**Mini-Project 3:** Smart Mobile Application as a Travel / Route Guide, Scenario - You are visiting an ancient monument. There is no local guide available. The previous users have commented on various locations where artifacts can be seen, photo are uploaded. The smart mobile application will give you directions / recommendations / suggestions on what to see and where, including narratives on the same.
8.	**Mini-Project 4:** Design and build a 'Multifunctional Application' in the Mobile and Pervasive domain. The choice of application is to be determined so as to leverage the capabilities of typical smart devices. These include such characteristics as, - Location awareness and GPS systems - Accelerometers - Messaging - Sensor detection capability - Microphone and Camera - Media Player - Touch screen - Mapping Technology - Mobile Web Services
	410244(D): Data Mining and Warehousing
1.	For an organization of your choice, choose a set of business processes. Design star / snow flake schemas for analyzing these processes. Create a fact constellation schema by combining them. Extract data from different data sources, apply suitable transformations and load into destination tables using an ETL tool. **For Example:** Business Origination: Sales, Order, Marketing Process.
2.	Consider a suitable dataset. For clustering of data instances in different groups, apply different clustering techniques (minimum 2). Visualize the clusters using suitable tool.
3.	Apply a-priori algorithm to find frequently occurring items from given data and generate strong association rules using support and confidence thresholds. **For Example:** Market Basket Analysis
4.	Consider a suitable text dataset. Remove stop words, apply stemming and feature selection techniques to represent documents as vectors. Classify documents and evaluate precision, recall.
5.	**Mini project on classification:** Consider a labeled dataset belonging to an application domain. Apply suitable data preprocessing steps such as handling of null values, data reduction, discretization. For prediction of class labels of given data instances, build classifier models using different techniques (minimum 3), analyze the confusion matrix and compare these models. Also apply cross validation while preparing the training and testing datasets.

	For Example: Health Care Domain for predicting disease.

410245: Elective II

410245(A): Distributed Systems

1.	Design and develop a basic prototype distributed system (e.g. a DFS).
2.	Design and implement client server application using RPC/ RMI mechanism (Java)
3.	Design and implement a clock synchronization algorithm for prototype DS
4.	Implement Ring or Bully election algorithm for prototype DS.
5.	Implement Ricart Agrawala's distributed algorithm for mutual exclusion.
6.	Problem solving of Wait-die and Wait –wound scheme for deadlock prevention.
7.	Simulate Wait for Graph based Centralized or Hierarchical or Distributed algorithm for deadlock detection.
8.	Implementation of 2PC / Byzantine Generals Problem

Mini-Projects

Important properties your system should have:

• The system must support multiple, autonomous agents (either human or automated) contending for shared resources and performing real-time updates to some form of shared state.

• The state of the system should be distributed across multiple client or server nodes.

 The only centralized service should be one that supports users logging on, adding or removing clients or servers, and other housekeeping tasks.

•The system should be robust

   The system should be able to continue operation even if one of the participant nodes crashes.

It should be possible to recover the state of a node following a crash, so that it can resume operation. We will let you choose your own application, and we will give you wide latitude in the overall and the detailed design of your implementation.

Design, implement, and thoroughly test a distributed system, implementing - Shared document editing, in the style of Google docs. The system should support real-time editing and viewing by multiple participants. Multiple replicas would be maintained for fault tolerance. Caching and/or copy migration would be useful to minimize application response time.

Design, implement, and thoroughly test a distributed system, implementing - A low-latency notification system. E.g., watch a whole bunch of RSS feeds and send all subscribers an email when one is updated. Interface with both the raw RSS feeds and Google's update notification service. Replicate and partition the state of the monitoring system so that it can scale and survive node failures.

Design, implement, and thoroughly test a distributed system, implementing - An airline reservation system. Each airline would maintain its own collection of servers, with enough state replication to enable automatic fail-over. It would be possible to book travel that involves multiple airlines.

Design, implement, and thoroughly test a distributed system, implementing - Implement a distributed file system that does something interesting. Maybe you want one for storing your MP3s or movies. Or perhaps for something entirely different.

410245(B): Software Testing and Quality Assurance

1.	**Mini-Project 1:** Create a small application by selecting relevant system environment / platform and programming languages. Narrate concise Test Plan consisting features to be tested and bug taxonomy. Prepare Test Cases inclusive of Test Procedures for identified Test Scenarios. Perform selective Black-box and White-box testing covering Unit and Integration test by using suitable Testing tools. Prepare Test Reports based on Test Pass/Fail Criteria and judge the acceptance of application developed.
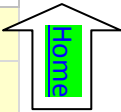
2.	**Mini-Project 2:** Create a small web-based application by selecting relevant system environment / platform and programming languages. Narrate concise Test Plan consisting features to be tested and bug taxonomy. Narrate scripts in order to perform regression tests. Identify the bugs using Selenium WebDriver and IDEand generate test reports encompassing exploratory testing.

410245(C):: Operations Research

1.	**The Transportation Problem:**
	Milk in a milk shed area is collected on three routes A, B and C. There are four chilling centers P, Q, R and S where milk is kept before transporting it to a milk plant. Each route is able to supply on an average one thousand liters of milk per day. The supply of milk on routes A, B and C are 150, 160 and 90 thousand liters respectively. Daily capacity in thousand liters of chilling centers is 140, 120, 90 and 50 respectively. The cost of transporting 1000 liters of milk from each route (source) to each chilling center (destination) differs according to the distance. These costs (in Rs.) are shown in the following table

Routes	Chilling Centers

Routes	P	Q	R	S
A	16	18	21	12
B	17	19	14	13
C	32	11	15	10

The problem is to determine how many thousand liters of milk is to be transported from each route on daily basis in order to minimize the total cost of transportation.

2.	**Investment Problem:**
	A portfolio manager with a fixed budget of $100 million is considering the eight investment opportunities shown in Table 1. The manager must choose an investment level for each alternative ranging from $0 to $40 million. Although an acceptable investment may assume any value within the range, we discretize the permissible allocations to intervals of $10 million to facilitate the modeling. This restriction is important to what follows. For convenience we define a unit of investment to be $10 million. In these terms, the budget is 10 and the amounts to invest are the integers in the range from 0 to 4. Following table provides the net annual returns from the investment opportunities expressed in millions of dollars. A ninth opportunity, not shown in the table, is available for funds left over from the first eight investments. The return is 5% per year for the amount invested, or equivalently, $0.5 million for each $10 million invested. The manager's goal is to maximize the total annual return without exceeding the budget

Returns from Investment Opportunities								
Amount Invested ($10 million)	Opportunity
	1	2	3	4	5	6	7	8
0	0	0	0	0	0	0	0	0
1	4.1	1.8	1.5	2.2	1.3	4.2	2.2	1.0
2	5.8	3.0	2.5	3.8	2.4	5.9	3.5	1.7
3	6.5	3.9	3.3	4.8	3.2	6.6	4.2	2.3
4	6.8	4.5	3.8	5.5	3.9	6.8	4.6	2.8

410245(D):: Mobile Communication

1.	Design simple GUI application with activity and intents e.g. Design an android Application for Phone Call or Calculator
2.	Design an android application for media player.
3.	Design an android Application for SMS Manager

4.	Design an android Application using Google Map To Trace The Location of Device
5.	Design an android Application for Frame Animation
6.	**Mini-Project 1:** Design mobile app to perform the task of creating the splash screen for the application using timer, camera options and integrate Google map API on the first page of the application. Make sure map has following features: • Zoom and View change • Navigation to specific locations • Marker and getting location with touch • Monitoring of location
7.	**Mini-Project 2:** Create an app to add of a product to SQLite database and make sure to add following features • SMS messaging and email provision • Bluetooth options • Accessing Web services • Asynchronous remote method call • Use Alert box for user notification
8.	**Mini-Project 3:** Create the module for collecting cellular mobile network performance parameters using telephony API Manager • Nearest Base Station • Signal Strengths • SIM Module Details • Mobility Management Information
9.	**Mini-Project 4:** Create an application for Bank using spinner, intent • Form 1: Create a new account for customer, Form 2: Deposit money in customer account. Link both forms, after completing of first form the user should be directed to the second form. Provide different menu options
10.	**Mini-Project 5:** Create the module for payment of fees for College by demonstrating the following methods. • Fees Method()- for calculation of fees, Use customized Toast for successful payment of fees, Implement an alarm in case someone misses out on the fee submission deadline • Demonstrate the online payment gateway.
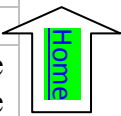
Savitribai Phule Pune University
Fourth Year of Computer Engineering (2015 Course)
410248:Project Work Stage I

Teaching Scheme: Practical : 02 Hours/Week	Credit 02	Examination Scheme: Presentation: 50 Marks

Course Objectives:

- To Apply the knowledge for solving realistic problem
- To develop problem solving ability
- To Organize, sustain and report on a substantial piece of team work over a period of several months
- To Evaluate alternative approaches, and justify the use of selected tools and methods,
- To Reflect upon the experience gained and lessons learned,
- To Consider relevant social, ethical and legal issues,
- To find information for yourself from appropriate sources such as manuals, books, research journals and from other sources, and in turn increase analytical skills.
- To Work in TEAM and learn professionalism.

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.
- Write precise reports and technical documents in a nutshell.
- Participate effectively in multi-disciplinary and heterogeneous teams exhibiting team work, Inter-personal relationships, conflict management and leadership quality.

Guidelines

Project work Stage – I is an integral part of the Project work. In this, the student shall complete the partial work of the Project which will consist of problem statement, literature review, SRS, Model and Design. The student is expected to complete the project at least up to the design phase. As a part of the progress report of project work Stage-I, the candidate shall deliver a presentation on the advancement in Technology pertaining to the selected project topic. The student shall submit the duly certified progress report of Project work Stage-I in standard format for satisfactory completion of the work by the concerned guide and head of the Department/Institute.

The examinee will be assessed by a panel of examiners of which one is necessarily an external examiner. The assessment will be broadly based on work undergone, content delivery, presentation skills, documentation, question-answers and report.

Follow guidelines and formats as mentioned in Project Workbook recommended by Board of Studies.

Home

Savitribai Phule Pune University
Fourth Year of Computer Engineering (2015 Course)
410249: Audit Course 5

In addition to credits, it is recommended that there should be audit course in preferably in each semester from second year to supplement their knowledge and skills. Student will be awarded the bachelor's degree if he/she earns 190 credits and clears all the audit courses specified in the syllabus. The student will be awarded grade as AP on successful completion of audit course. The student may opt for one of the audit courses per semester, starting in second year first semester. Though not mandatory, such a selection of the audit courses helps the learner to explore the subject of interest in greater detail resulting in achieving the very objective of audit course's inclusion. List of options offered is provided. Each student has to choose one audit course from the list per semester. Evaluation of audit course will be done at institute level itself. Method of conduction and method of assessment for audit courses are suggested.

Criteria:

The student registered for audit course shall be awarded the grade AP (Audit Course Pass) and shall be included such AP grade in the Semester grade report for that course, provided student has the minimum attendance as prescribed by the Savitribai Phule Pune University and satisfactory in-semester performance and secured a passing grade in that audit course. No grade points are associated with this 'AP' grade and performance in these courses is not accounted in the calculation of the performance indices SGPA and CGPA. Evaluation of audit course will be done at institute level itself. (Ref- http://www.unipune.ac.in/Syllabi_PDF/revised-2015/engineering/UG_RULE_REGULATIONS_FOR_CREDIT_SYSTEM-2015_18June.pdf)

Guidelines for Conduction and Assessment (Any one or more of following but not limited to)

- Lectures/ Guest Lectures
- Visits (Social/Field) and reports
- Demonstrations

- Surveys
- Mini Project
- Hands on experience on specific focused topic

Guidelines for Assessment (Any one or more of following but not limited to)

- Written Test
- Demonstrations/ Practical Test
- Presentations

- IPR/Publication
- Report

Audit Course 3 Options

AC5- I	Entrepreneurship Development
AC5-II	Botnet of Things
AC5-III	3D Printing
AC5-IV	Industrial Safety and Environment Consciousness
AC5-V	Emotional Intelligence
AC5-VI	MOOC-Learn New Skill

Note: It is permitted to opt one of the audit courses listed at SPPU website too, if not opted earlier http://collegecirculars.unipune.ac.in/sites/documents/Syllabus%202017/Forms/AllItems.aspx

Savitribai Phule Pune University, Pune
Fourth Year of Computer Engineering (2015 Course)
410249: Audit Course 5
AC5 – I: Entrepreneurship Development

This Course Aims at Instituting Entrepreneurial skills in the students by giving an overview of, who the entrepreneurs are and what competences are needed to become an entrepreneur.

Course Objectives:
- To introduce the aspects of Entrepreneurship
- To acquaint with legalities in product development
- To understand IPR, Trademarks, Copyright and patenting
- To   know the facets of functional plans, Entrepreneurial Finance and Enterprise Management

Course Outcomes:
On completion of the course, learner will be able to–
- Understand the legalities in product development
- Undertake the process of IPR, Trademarks, Copyright and patenting
- Understand and apply functional plans
- Manage Entrepreneurial Finance
- Inculcate managerial skill as an entrepreneur

Course Contents:

1. **Introduction:** Concept and Definitions, Entrepreneur v/s Intrapreneur; Role of entrepreneurship in economic development; Entrepreneurship process; Factors impacting emergence of entrepreneurship; Managerial versus entrepreneurial Decision Making; Entrepreneur   v/s Investors; Entrepreneurial attributes and characteristics; Entrepreneurs versus inventors; Entrepreneurial Culture; Women Entrepreneurs; Social Entrepreneurship; Classification and Types of Entrepreneurs; EDP Programmers; Entrepreneurial Training; Traits/Qualities of an Entrepreneurs.

2. **Creating Entrepreneurial Venture :** Generating Business idea- Sources of Innovation, methods of generating ideas, Creativity and Entrepreneurship; Business planning process; Drawing business plan; Business plan failures; Entrepreneurial   leadership – components of entrepreneurial leadership; Entrepreneurial Challenges;   Legal issues – forming business entity, considerations and Criteria, requirements for formation of a Private/Public Limited Company, Intellectual Property Protection - Patents Trademarks and Copyrights.

3. **Functional plans:** Marketing plan–for the new venture, environmental analysis, steps in preparing marketing plan, marketing mix, contingency planning; Organizational plan – designing organization structure and Systems; Financial plan – pro forma income statements, Ratio Analysis.

4. **Entrepreneurial Finance:** Debt or equity financing, Sources of Finance - Commercial banks, private placements, venture capital, financial institutions supporting entrepreneurs; Lease Financing; Funding opportunities for Startups in India.

5. **Enterprise Management:** Managing growth and sustenance- growth norms; Factors for growth; Time management, Negotiations, Joint ventures, Mergers and acquisitions

Books:
1. Kumar, Arya,`` Entrepreneurship: Creating and Leading an Entrepreneurial Organization'', Pearson ISBN-10: 8131765784; ISBN-13: 978-8131765784 ...
2. Hishrich., Peters, ``Entrepreneurship: Starting, Developing and Managing a New Enterprise'', ISBN 0-256-14147- 9
3. Irwin Taneja, ``Entrepreneurship,'' Galgotia Publishers. ISBN: 978-93-84044-82-4
4. Charantimath, Poornima, ``Entrepreneurship Development and Small Business Enterprises,'' Pearson Education, ISBN, 8177582607, 9788177582604.
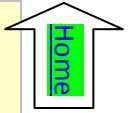
Home

Savitribai Phule Pune University, Pune
Fourth Year of Computer Engineering (2015 Course)
410249: Audit Course 5
AC5 – II: Botnet of Things

This course aims to provide an understanding of the various security attacks and knowledge to recognize and remove common coding errors that lead to vulnerabilities. It gives an outline of the techniques for developing a secure application.

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

Books:

1. Bernd Scholz - Reiter, Florian Michahelles, "Architecting the Internet of Things", Springer ISBN 978 – 3 – 642 – 19156 - 5 e - ISBN 978 – 3 -642 - 19157 - 2,
2. Threat Modeling, Frank Swiderski and Window Snyder,Microsoft Professional, 1 st Edition 2004
3. Gunter Ollmann 2007. The Phishing Guide Understanding and Preventing Phishing Attacks. IBM Internet Security Systems.
4. Daniel Minoli, "Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications", ISBN: 978 – 1 – 118 – 47347 - 4, Willy Publications
5. White Papers :- https://www.sans.org/reading-room/whitepapers/malicious/bots-botnet-overview-1299
6. https://www-01.ibm.com/marketing/iwm/dre
7. Mike Kuniavsky, "Smart Things: Ubiquitous Computing User Experience Design," Morgan Kaufmann Publishers.

Home

Savitribai Phule Pune University, Pune
Fourth Year of Computer Engineering (2015 Course)
410249: Audit Course 5
AC5 – III: 3D Printing

Course Objectives:
- To understand the principle of 3D printing
- To understand resource requirements of 3D printing
- To know the basic artwork needed for 3D printing

Course Outcomes:

On completion of the course, learner will be able to–
- Apply models for 3D printing
- Plan the resources for 3D printing
- Apply principles in 3D printing in real world

Course Contents:

1. Getting Started with 3D Printing: How 3D Printers Fit into Modern Manufacturing, Exploring the Types of 3D Printing, Exploring Applications of 3D Printing.

2. Outlining 3D Printing Resources: Identifying Available Materials for 3D Printing, Identifying Available Sources for 3D Printable Objects.

3. Exploring the Business Side of 3D Printing: Commoditizing 3D Printing, Understanding 3D Printing's Effect on Traditional lines of Business, Reviewing 3D Printing Research.

4. Employing Personal 3D printing Devices: Exploring 3D printed Artwork, Considering Consumer level 3D Printers, Deciding on RepEap of Your Own.

Books:
1. Richard Horne, Kalani Kirk Hausman, " 3D Printing for Dummies", Taschenbuch, ISBN: 9781119386315
2. Greg Norton, "3D Printing Business - 3D Printing for Beginners - How to 3D Print" ,ISBN:9781514785669
3. Liza Wallach Kloski and Nick Kloski, " Getting Started with 3D Printing: A Hands-on Guide to the Hardware, Software, and Services Behind the New Manufacturing Revolution", Maker Media, ISBN: 1680450204
4. Jeff Heldrich , "3D Printing: Tips on Getting Started with 3D Printing to Help you make Passive income for your Business"
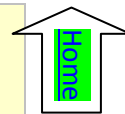
Home

Savitribai Phule Pune University, Pune
Fourth Year of Computer Engineering (2015 Course)
410249: Audit Course 5
AC5 – IV: Industrial Safety and Environment Consciousness

Objective of Industrial Safety, Health Environment and Security covers virtually every important area in administration of SHE. It broadly discusses the major problems in safety management, occupational health and today's dynamic environment management of rapidly changing ambience, technological advances, whole gamut of safety laws, safety policy and it's designing and their meticulous implementation.

Course Objectives:
- To understand Industrial hazards and Safety requirements with norms
- To learn the basics of Safety performance planning
- To know the means of accident prevention
- To understand the impact of industrialization on environment
- To know the diversified industrial requirements of safety and security

Course Outcomes:
On completion of the course, learner will be able to–
- Formulate the plan for Safety performance
- Formulate the action plan for accidents and hazards
- Follow the safety and security norms in the industry
- Consider critically the environmental issues of Industrialization

Course Contents:

1. Introduction: Elements of safety programming, safety management, Upgrading developmental programmers: safety procedures and performance measures, education, training and development in safety.

2. Safety Performance Planning
Safety Performance: An overview of an accident, It is an accident, injury or incident, The safety professional, Occupational health and industrial hygiene. Understanding the risk: Emergency preparedness and response, prevention of accidents involving hazardous substances.

3. Accident Prevention
What is accident prevention?, Maintenance and Inspection, Monitoring Techniques, General Accident Prevention, Safety Education and Training.

4. Safety Organization
Basic Elements of Organized Safety, Duties of Safety Officer, Safe work Practices, Safety Sampling and Inspection, Job Safety Analysis(JSA), Safety Survey, On- site and Off-site Emergency Plan, Reporting of Accidents and Dangerous Occurrences.

5. Environment
Introduction, Work Environment, Remedy, pollution of Marine Environment and Prevention, Basic Environmental Protection Procedures, Protection of Environment in Global Scenario, Greenhouse Gases, Climate Change Impacts, GHG Mitigation Options, Sinks and Barriers,

6. Industrial Security(Industry wise)
General security Systems in Factories, Activation Security, Computer Security, Banking Security, V.I.P. Security, Women Security, Event Security, Security in Open Environments.

Books:
1. Basudev Panda ,"Industrial Safety, Health Environment and Security",Laxmi Publications, ISBN-10: 9381159432, 13: 978-9381159439
2. L.M. Deshmukh, "Industrial Safety Management", TMH , ISBN: 9780070617681
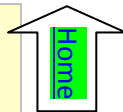
Savitribai Phule Pune University, Pune
Fourth Year of Computer Engineering (2015 Course)
410249: Audit Course 5
AC5 – V: Emotional Intelligence

This Emotional Intelligence (EI) training course will focus on the five core competencies of emotional intelligence: self-awareness, self-regulation, motivation, empathy and interpersonal skills. Participants will learn to develop and implement these to enhance their relationships in work and life by increasing their understanding of social and emotional behaviors, and learning how to adapt and manage their responses to particular situations. Various models of emotional intelligence will be covered.

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–
- Expand your knowledge of emotional patterns in yourself and others
- Discover how you can manage your emotions, and positively influence yourself and others
- Build more effective relationships with people at work and at home
- Positively influence and motivate colleagues, team members, managers
- 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.

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, Pune
Third Year of Computer Engineering (2015 Course)
410249: Audit Course 5
410257: Audit Course 6
AC5 – VI & AC6-VI: MOOC-Learn New Skill

Course Objectives:

- To promote interactive user forums to support community interactions among students, professors, and experts
- To promote learn additional skills anytime and anywhere
- To enhance teaching and learning on campus and online

Course Outcomes:

On completion of the course, learner will acquire additional knowledge and skill.

About Course:

MOOCs (Massive Open Online Courses) provide affordable and flexible way to learn new skills, pursue lifelong interests and deliver quality educational experiences at scale. Whether you're interested in learning for yourself, advancing your career or leveraging online courses to educate your workforce, SWYAM, NPTEL, edx or similar ones can help.

World's largest SWAYAM MOOCs, a new paradigm of education for anyone, anywhere, anytime, as per your convenience, aimed to provide digital education free of cost and to facilitate hosting of all the interactive courses prepared by the best more than 1000 specially chosen faculty and teachers in the country. SWAYAM MOOCs enhances active learning for improving lifelong learning skills by providing easy access to global resources.

SWAYAM is a programme initiated by Government of India and designed to achieve the three cardinal principles of Education Policy viz., access, equity and quality. The objective of this effort is to take the best teaching learning resources to all, including the most disadvantaged. SWAYAM seeks to bridge the digital divide for students who have hitherto remained untouched by the digital revolution and have not been able to join the mainstream of the knowledge economy.

This is done through an indigenous developed IT platform that facilitates hosting of all the courses, taught in classrooms from 9th class till post-graduation to be accessed by anyone, anywhere at any time. All the courses are interactive, prepared by the best teachers in the country and are available, free of cost to the residents in India. More than 1,000 specially chosen faculty and teachers from across the Country have participated in preparing these courses.

The courses hosted on SWAYAM is generally in 4 quadrants – (1) video lecture, (2) specially prepared reading material that can be downloaded/printed (3) self-assessment tests through tests and quizzes and (4) an online discussion forum for clearing the doubts. Steps have been taken to enrich the learning experience by using audio-video and multi-media and state of the art pedagogy / technology. In order to ensure best quality content are produced and delivered, seven National Coordinators have been appointed: They are NPTEL for engineering and UGC for post-graduation education.

Guidelines:

Instructors are requested to promote students to opt for courses (not opted earlier) with proper mentoring. The departments will take care of providing necessary infrastructural and facilities for the learners.

References:

1. https://swayam.gov.in/
2. https://onlinecourses.nptel.ac.in/
3. https://www.edx.org

SEMESTER
II

Savitribai Phule Pune University **Fourth Year of Computer Engineering (2015 Course)** **410250: Machine Learning**		
Teaching Scheme: **TH: 03 Hours/Week**	**Credit** **03**	**Examination Scheme:** **In-Sem (Paper): 30 Marks** **End-Sem (Paper): 70 Marks**

Prerequisite Courses: 207003- Engineering Mathematics III

Companion Course: 410254- Laboratory Practice III

Course Objectives:
- To understand human learning aspects and relate it with machine learning concepts.
- To understand nature of the problem and apply machine learning algorithm.
- To find optimized solution for given problem.

Course Outcomes:

On completion of the course, student will be able to–
- Distinguish different learning based applications
- Apply different preprocessing methods to prepare training data set for machine learning.
- Design and implement supervised and unsupervised machine learning algorithm.
- Implement different learning models
- Learn Meta classifiers and deep learning concepts

	Course Contents	
Unit I	**Introduction to Machine learning**	**08 Hours**

Classic and adaptive machines, Machine learning matters, Beyond machine learning-deep learning and bio inspired adaptive systems, Machine learning and Big data.

Important Elements of Machine Learning- Data formats, Learnability, Statistical learning approaches, Elements of information theory.

Unit II	**Feature Selection**	**08 Hours**

Scikit- learn Dataset, Creating training and test sets, managing categorical data, Managing missing features, Data scaling and normalization, Feature selection and Filtering, Principle Component Analysis(PCA)-non negative matrix factorization, Sparse PCA, Kernel PCA. Atom Extraction and Dictionary Learning.

Unit III	**Regression**	**08 Hours**

Linear regression- Linear models, A bi-dimensional example, Linear Regression and higher dimensionality, Ridge, Lasso and ElasticNet, Robust regression with random sample consensus, Polynomial regression, Isotonic regression,

Logistic regression-Linear classification, Logistic regression, Implementation and Optimizations, Stochastic gradient descendent algorithms, Finding the optimal hyper-parameters through grid search, Classification metric, ROC Curve.

Unit IV	Naïve Bayes and Support Vector Machine	08 Hours

Bayes' Theorom, Naïve Bayes' Classifiers, Naïve Bayes in Scikit- learn- Bernoulli Naïve Bayes, Multinomial Naïve Bayes, and Gaussian Naïve Bayes.

Support Vector Machine(SVM)- Linear Support Vector Machines, Scikit- learn implementation- Linear Classification, Kernel based classification, Non- linear Examples. Controlled Support Vector Machines, Support Vector Regression.

Unit V	Decision Trees and Ensemble Learning	08 Hours

Decision Trees- Impurity measures, Feature Importance. Decision Tree Classification with Scikit-learn, Ensemble Learning-Random Forest, AdaBoost, Gradient Tree Boosting, Voting Classifier.

Clustering Fundamentals- Basics, K-means: Finding optimal number of clusters, DBSCAN, Spectral Clustering. Evaluation methods based on Ground Truth- Homogeneity, Completeness, Adjusted Rand Index.

Introduction to Meta Classifier: Concepts of Weak and eager learner, Ensemble methods, Bagging, Boosting, Random Forests.

Unit VI	Clustering Techniques	08 Hours

Hierarchical Clustering, Expectation maximization clustering, Agglomerative Clustering-Dendrograms, Agglomerative clustering in Scikit- learn, Connectivity Constraints.

Introduction to Recommendation Systems- Naïve User based systems, Content based Systems, Model free collaborative filtering-singular value decomposition, alternating least squares.

Fundamentals of Deep Networks-Defining Deep learning, common architectural principles of deep networks, building blocks of deep networks.

Books:

Text:
1. Giuseppe Bonaccorso, "Machine Learning Algorithms", Packt Publishing Limited**,** ISBN-10: 1785889621, ISBN-13: 978-1785889622
2. Josh Patterson, Adam Gibson, "Deep Learning: A Practitioners Approach", O'REILLY, SPD, ISBN: 978-93-5213-604-9, 2017 Edition 1st.

References:
1. Ethem Alpaydin, " Introduction to Machine Learning", PHI 2nd Edition-2013, ISBN 978-0-262-01243-0
2. 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
3. Tom Mitchell "Machine Learning" McGraw Hill Publication, ISBN :0070428077 9780070428072
4. Nikhil Buduma, "Fundamentals of Deep Learning", O'REILLY publication, second edition 2017, ISBN: 1491925612

Savitribai Phule Pune University
Fourth Year of Computer Engineering (2015 Course)
410251: Information and Cyber Security

Teaching Scheme: TH: 03 Hours/Week	Credit 03	Examination Scheme: In-Sem (Paper): 30 Marks End-Sem (Paper): 70 Marks

Prerequisite Courses: 310245-Computer Networks

Companion Course: 410254: Laboratory Practice III

Course Objectives:
- To offer an understanding of principle concepts, central topics and basic approaches in information and cyber security.
- To know the basics of cryptography.
- To acquire knowledge of standard algorithms and protocols employed to provide confidentiality, integrity and authenticity.
- To enhance awareness about Personally Identifiable Information (PII), Information Management, cyber forensics.

Course Outcomes:
On completion of the course, student will be able to–
- Gauge the security protections and limitations provided by today's technology.
- Identify information security and cyber security threats.
- Analyze threats in order to protect or defend it in cyberspace from cyber-attacks.
- Build appropriate security solutions against cyber-attacks.

Course Contents		
Unit I	**Security Basics**	**08 Hours**

Introduction, Elements of Information Security, Security Policy, Techniques, Steps, Categories, Operational Model of Network Security, Basic Terminologies in Network Security. Threats and Vulnerability, Difference between Security and Privacy.

Unit II	**Data Encryption Techniques And Standards**	**08 Hours**

Introduction, Encryption Methods: Symmetric, Asymmetric, Cryptography, Substitution Ciphers. Transposition Ciphers, Stenography applications and limitations, Block Ciphers and methods of operations, Feistal Cipher, Data Encryption Standard (DES), Triple DES, DES Design Criteria, Weak Keys in DES Algorithms, Advance Encryption Standard (AES).

Unit III	**Public Key And Management**	**08 Hours**

Public Key Cryptography, RSA Algorithm: Working, Key length, Security, Key Distribution, Deffie-Hellman Key Exchange, Elliptic Curve: Arithmetic, Cryptography, Security, Authentication methods, Message Digest, Kerberos, X.509 Authentication service.

Digital Signatures: Implementation, Algorithms, Standards (DSS), Authentication Protocol.

Unit IV	**Security Requirements**	**08 Hours**

IP Security: Introduction, Architecture, IPV6, IPv4, IPSec protocols, and Operations, AH Protocol, ESP Protocol, ISAKMP Protocol, Oakkey determination Protocol, VPN. WEB Security: Introduction, Secure Socket Layer (SSL), SSL Session and Connection, SSL Record Protocol, Change Cipher Spec Protocol, Alert Protocol, Handshake Protocol. Electronic Mail Security: Introduction, Pretty Good Privacy, MIME, S/MIME, Comparison. Secure Electronic Transaction (SET).

Unit V	Firewall And Intrusion	08 Hours

Introduction, Computer Intrusions. Firewall Introduction, Characteristics and types, Benefits and limitations. Firewall architecture, Trusted Systems, Access Control. Intrusion detection, IDS: Need, Methods, Types of IDS, Password Management, Limitations and Challenges.

Unit VI	Confidentiality And Cyber Forensic	08 Hours

Introduction to Personally Identifiable Information (PII), Cyber Stalking, PII impact levels with examples Cyber Stalking, Cybercrime, PII Confidentiality Safeguards, Information Protection Law: Indian Perspective.

Books:

Text:
1. Bernard Menezes, "Network Security and Cryptography", Cengage Learning India, 2014, ISBN No.: 8131513491
2. Nina Godbole, Sunit Belapure, "Cyber Security", Wiley India, 2014, ISBN No.: 978-81-345-2179-1

References:
1. Eoghan Casey, "Digital Evidence and Computer Crime Forensic Science, Computers and the Internet", ELSEVIER, 2011, ISBN 978-0-12-374268-1
2. Atul Kahate, "Cryptography and Network Security", Mc Graw Hill Publication, 2nd Edition, 2008, ISBN : 978-0-07-064823-4
3. William Stallings, "Cryptography and network security principles and practices", Pearson, 6th Edition, ISBN : 978-93-325-1877-3
4. Forouzan, "Cryptography and Network Security (SIE)", Mc Graw Hill, ISBN, 007070208X, 9780070702080
5. Dr. Nilakshi Jain-Digital Forensic: The Fascinating World of Digital Evidences-Wiley India-ISBN: 9788126565740

Savitribai Phule Pune University
Fourth Year of Computer Engineering (2015 Course)
Elective III
410252(A): Advanced Digital Signal Processing

Teaching Scheme: TH: 03 Hours/Week	Credit 03	Examination Scheme: In-Sem (Paper): 30 Marks End-Sem (Paper): 70 Marks

Prerequisite Courses: 410244(A)Digital Signal Processing

Companion Course: 410255-Laboratory Practice IV

Course Objectives:
- To study the parametric methods for power spectrum estimation.
- To study adaptive filtering techniques and applications of adaptive filtering.
- To learn and understand Multi-rate DSP and applications
- To explore appropriate transforms
- Understand basic concepts of speech production, speech analysis, speech coding and parametric representation of speech
- Acquire knowledge about different methods used for speech coding and understand various applications of speech processing
- Learn and understand basics of Image Processing and various image filters with its applications

Course Outcomes:
On completion of the course, student will be able to–
- Understand and apply different transforms for the design of DT/Digital systems
- Explore the knowledge of adaptive filtering and Multi-rate DSP
- Design DT systems in the field/area of adaptive filtering, spectral estimation and multi-rate DSP
- Explore use of DCT and WT in speech and image processing
- Develop algorithms in the field of speech , image processing and other DSP applications

Course Contents		
Unit I	**DFT and Applications**	**08 Hours**

DFT and Applications – Linear filtering, spectral leakage, Spectral resolution and selection of Window Length, Frequency analysis, 2-D DFT, applications in Image and Speech Processing

Unit II	**Adaptive FIR and IIR filter Design**	**08 Hours**

Adaptive FIR and IIR filter Design – DT Filters, FIR and IIR filters, Adaptive FIR Filter design: Steepest descent and Newton method, LMS method, Applications, Adaptive IIR Filter design: Pade Approximation, Least square design, Applications

Unit III	**Multi-rate DSP and applications**	**08 Hours**

Multi-rate DSP and applications – Decimation, Interpolation, sampling rate conversion, polyphone filter structures, multistage filter design, applications

Unit IV	**Spectral Estimation**	**08 Hours**
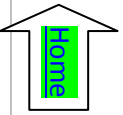
Spectral Estimation – Estimation of density spectrum, Nonparametric method, Parametric method, Evaluation ,DCT and WT – DCT and KL transform, STFT, WT, Harr Wavelet and Dubecheis Wavelet, Applications of DCT and WT.

Unit V	Speech processing	08 Hours

Speech processing - Speech coding: Phase Vocoder, LPC, Sub-band coding, Adaptive Transform Coding, Harmonic Coding, Vector Quantization based Coders. Fundamentals of Speech recognition, Speech segmentation, Text-to-speech conversion, speech enhancement, Speaker Verification, Applications.

Unit VI	Image Processing	08 Hours

Image Processing – Image as 2D signal and image enhancement techniques, filter design: low pass, highpass and bandpass for image smoothing and edge detection, Optimum linear filter and order statistic filter, Examples – Wiener and Median filters, Applications

Books:

Text:

1. J. G. Proakis, D. G. Manolakis, " Digital Signal Processing: Principles, Algorithms, and Applications," Prentice Hall, 2007, 4th edition, ISBN: 10: 0131873741
2. Dr. Shaila D. Apate , " Advanced Digital Signal Processing," Wiley Publ., 2013, *ISBN*-10: 8126541245
3. S. K. Mitra, "Digital Signal Processing : A Computer Based Approach", McGraw Hill Higher Education, 2006, 3rd edition, *ISBN*-10: 0070429537
4. Rabiner and Juang, "Fundamentals of Speech Recognition", Prentice Hall, 1994, ISBN:0-13-015157-2 .
5. Rafael C. Gonzalez, Richard E. Woods, "Digital Image Processing and Analysis", Pearson Education, 3d Ed., 2007, ISBN: 81-7808-629-8

References:

1. Chanda, Muzumdar, "Digital Image Processing and Analysis," Estern Economy Edition, PHI, 2nd Ed., ISBN: 978-81-203-4096-*1*
2. TarunRawat, "Digital Signal Processing", Oxford University Press, 2015, ISBN-10: 0198062281
3. Roberto Crist, "Modern Digital Signal Processing," Thomson Brooks/Cole 2004, ISBN:978-93-80026-55-8.
4. Nelson Morgan and Ben Gold, " Speech and Audio Signal Processing: Processing and Perception Speech and Music", 1999, John Wiley and Sons, ISBN: 0387951547
5. Raghuveer. M. Rao, AjitS.Bopardikar, "Wavelet Transforms: Introduction to Theory and applications," Pearson Education, Asia, 2000.Dale Grover and John R. (Jack) Deller, "Digital Signal Processing and the Microcontroller", Prentice Hall, ISBN:0-13-754920-2
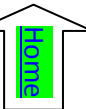
Savitribai Phule Pune University
Fourth Year of Computer Engineering (2015 Course)
Elective III
410252(B): Compilers

Teaching Scheme: TH: 03 Hours/Week	Credit 03	Examination Scheme: In-Sem (Paper): 30 Marks End-Sem (Paper): 70 Marks

Prerequisite Courses: Theory of Computation(310241), 310251-Systems Programming and Operating System

Companion Course: 410255-Laboratory Practice IV

Course Objectives:

- To introduce process of compilation
- To introduce complier writing tools
- To address issues in code generation and optimization

Course Outcomes:

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

- Design and implement a lexical analyzer and a syntax analyzer
- Specify appropriate translations to generate intermediate code for the given programming language construct
- Compare and contrast different storage management schemes
- Identify sources for code optimization

Course Contents

Unit I	Notion and Concepts	08 Hours

Introduction to compilers Design issues, passes, phases, symbol table Preliminaries Memory management, Operating system support for compiler, Lexical Analysis Tokens, Regular Expressions, Process of Lexical analysis, Block Schematic, Automatic construction of lexical analyzer using LEX, LEX features and specification.

Unit II	Parsing	08 Hours

Syntax Analysis CFG, top-down and bottom-up parsers, RDP, Predictive parser, SLR, LR(1), LALR parsers, using ambiguous grammar, Error detection and recovery, automatic construction of parsers using YACC, Introduction to Semantic analysis, Need of semantic analysis, type checking and type conversion.

Unit III	Syntax Translation Schemes	08 Hours
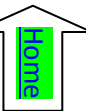
Syntax Directed Translation - Attribute grammar, S and L attributed grammar, bottom up and top down evaluations of S and L attributed grammar, Syntax directed translation scheme, Intermediate code - need, types: Syntax Trees, DAG, Three-Address codes: Quadruples, Triples and Indirect Triples, Intermediate code generation of declaration statement and assignment statement.

Unit IV	Run-time Storage Management	08 Hours

Storage Management – Static, Stack and Heap, Activation Record, static and control links, parameter passing, return value, passing array and variable number of arguments, Static and Dynamic scope, Dangling Pointers, translation of control structures – if, if-else statement, Switch-case, while, do -while statements, for, nested blocks, display mechanism, array assignment, pointers, function call and return. Translation of OO constructs: Class, members and Methods.

Unit V	Code Generation	08 Hours

Code Generation - Issues in code generation, basic blocks, flow graphs, DAG representation of basic blocks, Target machine description, peephole optimization, Register allocation and Assignment, Simple code generator, Code generation from labeled tree, Concept of code generator.

Unit VI	Code Optimization	08 Hours

Need for Optimization, local, global and loop optimization, Optimizing transformations, compile time evaluation, common sub-expression elimination, variable propagation, code movement, strength reduction, dead code elimination, DAG based local optimization, Introduction to global data flow analysis, Data flow equations and iterative data flow analysis.

Books:

Text:
1. V Aho, R Sethi, J D Ullman, "Compilers: Principles, Techniques, and Tools", Pearson Edition, ISBN 81-7758-590-8
2. Dick Grune, Bal, Jacobs, Langendoen, " Modern Compiler Design", Wiley, ISBN 81-265-0418-8

References:
1. Anthony J. Dos Reis, "Compiler Construction Using Java", JavaCC and Yacc Wiley, ISBN 978-0-470-94959-7
2. K Muneeswaran, "Compiler Design", Oxford University press, ISBN 0-19-806664-3
3. J R Levin, T Mason, D Brown, "Lex and Yacc", O'Reilly, 2000 ISBN 81-7366-061-X
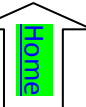
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Savitribai Phule Pune University Fourth Year of Computer Engineering (2015 Course) Elective III 410252(C): Embedded and Real Time Operating Systems		
Teaching Scheme: **TH: 03 Hours/Week**	**Credit** **03**	**Examination Scheme:** **In-Sem (Paper): 30 Marks** **End-Sem (Paper): 70 Marks**

Prerequisite Courses: 310251-Systems Programming and Operating System

Companion Course: 410255-Laboratory Practice IV

Course Objectives:
- To understand a typical embedded system and its constituents
- To learn the selection process of processor and memory for the embedded systems
- To learn communication buses and protocols used in the embedded and real-time systems
- To understand real-time operating system (RTOS) and the types of RTOS
- To learn various approaches to real-time scheduling
- To learn software development process and tools for RTOS applications

Course Outcomes:

On completion of the course, student will be able to–
- Recognize and classify embedded and real-time systems
- Explain communication bus protocols used for embedded and real-time systems
- Classify and exemplify scheduling algorithms
- Apply software development process to a given RTOS application
- Design a given RTOS based application

Course Contents		
Unit I	**Embedded Systems**	**08 Hours**

Introduction to Embedded systems, Characteristics, Challenges, Processors in Embedded systems, hardware Unit   s and devices in an embedded system – Power source, memory, real-time clocks, timers, reset circuits, watchdog-timer reset, Input-output ports, buses and interfaces, ADC, DAC, LCD, LED, Keypad, pulse dialer, modem, transceivers, embedded software, software are tools for designing an embedded system.

Unit II	**Embedded System On Chip (SOC)**	**08 Hours**

Embedded SOC, ASIC, IP core, ASIP, ASSP, examples of embedded systems. Advanced architectures/processors for embedded systems- ARM, SHARC, DSP, Superscalar Units. Processor organization, Memory organization, Performance metrics for a processor, memory map and addresses, Processor selection and memory selection for real-time applications.
Networked embedded systems- I2C, CAN, USB, Fire wire. Internet enabled systems- TCP, IP, UDP. Wireless and mobile system Protocols- IrDA, Bluetooth, 802.11, ZigBee.

Unit III	**I/O Communication**	**08 Hours**

Devices and communication buses: Types of I/O communication, types of serial communication, Serial protocols, Devices and buses- RS-232C, RS-485, HDLC, SPI, SCI, SI, SDIO. Parallel ports and interfacing. Parallel device protocols: ISA, PCI, PCI/X, ARM bus, Wireless devices.

Unit IV	**Real Time Operating System**	**08 Hours**

Introduction to real-time operating systems. Hard versus soft real-time systems and their timing constraints. Temporal parameters of real-time process: Fixed, Jittered and sporadic release times, execution time. Types of real-time tasks, Precedence constraints and data dependency among real-time tasks, other types of dependencies for real-time tasks. Functional parameters and Resource parameters of real-time process, Real-time applications: Guidance and control, Signal processing, Multimedia, real-time databases.

Real-time task and task states, task and data. Approaches to real-time scheduling: clock driver, weighted round-robin, priority-driven- Fixed priority and dynamic priority algorithms –Rate Monotonic (RM), Earliest-Deadline-First (EDF), Latest-Release-Time (LRT), Least-Slack-Time-First (LST). Static and Dynamic systems, on-line and off-line scheduling, Scheduling a-periodic and sporadic real-time tasks.

Unit V	Inter-process communication	08 Hours

Resources and resource access control-Assumption on resources and their usage, Enforcing mutual exclusion and critical sections, resource conflicts and blocking, Effects of resource contention and resource access control - priority inversion, priority inheritance.

Inter-process communication-semaphores, message queues, mailboxes and pipes. Other RTOS services-Timer function, events, Interrupts - enabling and disabling interrupts, saving and restoring context, interrupt latency, shared data problem while handling interrupts. Interrupt routines in an RTOS environment.

Unit VI	Multiprocessor Scheduling	08Hours

Multiprocessor Scheduling, resource access control and synchronization in Real-time Operating system. Real-time communication: Model, priority-based service disciplines for switched networks, weighted round-robin service disciplines, Medium access-control protocols for broadcast networks, internet and resource reservation protocols, real-time protocols. Software development process for embedded system: Requirements engineering, Architecture and design of an embedded system, Implementation aspects in an embedded system, estimation modeling in embedded software. Validation and debugging of embedded systems. Embedded software development tools. Debugging techniques. Real-time operating systems: Capabilities of commercial real-time operating systems, QNX/Neutrino, Microc/OS-II, VxWorks, Windows CE and RTLinux.

Books:

Text:
1. Raj Kamal, "Embedded Systems: Architecture, programming and Design", 2nd Edition, McGraw-Hill, ISBN: 13: 9780070151253
2. Jane W. S. Liu, "Real-Time Systems", Pearson Education, ISBN: 10: 0130996513
1. David E. Simon, "An Embedded Software Primer", Pearson Education, ISBN: :8177581546

References:
1. Sriram V. Iyer, Pankaj Gupta, "Embedded Real-time Systems Programming", Tata McGraw-Hill, ISBN: 13: 9780070482845
2. Dr. K. V. K. K. Prasad, "Embedded Real-Time Systems: Concepts: Design and Programming", Black Book, Dreamtech Press, ISBN: 10: 8177224611,13: 9788177224610

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Savitribai Phule Pune University
Fourth Year of Computer Engineering (2015 Course)
Elective III
410252(D): Soft Computing and Optimization Algorithms

Teaching Scheme: TH: 03 Hours/Week	Credit 03	Examination Scheme: In-Sem (Paper): 30 Marks End-Sem (Paper): 70 Marks

Prerequisite Courses: 310250-Design and Analysis of Algorithm

Companion Course: 410255-Laboratory Practice IV

Course Objectives:
- To know the basics behind the Design and development intelligent systems in the framework of soft computing
- To acquire knowledge of Artificial Neural Networks Fuzzy sets, Fuzzy Logic, Evolutionary computing and swarm intelligence
- To explore the applications of soft computing
- To understand the need of optimization

Course Outcomes:

On completion of the course, student will be able to–
- Apply soft computing methodologies, including artificial neural networks, fuzzy sets, fuzzy logic, fuzzy inference systems and genetic algorithms
- Design and development of certain scientific and commercial application using computational neural network models, fuzzy models, fuzzy clustering applications and genetic algorithms in specified applications.

Course Contents		
Unit I	**Introduction**	**08 Hours**

Introduction, soft computing vs. hard computing, various types of soft computing techniques, and applications of soft computing. Basic tools of soft computing – Fuzzy logic, neural network, evolutionary computing. Introduction: Neural networks, application scope of neural networks, fuzzy logic, genetic algorithm, and hybrid systems.

Unit II	**Fuzzy Sets and Logic**	**08 Hours**

Basic concepts of fuzzy logic, Fuzzy sets and Crisp sets, Fuzzy set theory and operations, Properties of fuzzy sets, Fuzzy and Crisp relations, Fuzzy to Crisp conversion. Membership functions, interference in fuzzy logic, fuzzy if-then rules, Fuzzy implications and Fuzzy algorithms, Fuzzyfications and Defuzzifications.

Unit III	**Fuzzy Systems**	**08 Hours**

Fuzzy Controller, Fuzzy rule base and approximate reasoning: truth values and tables in fuzzy logic, fuzzy propositions formation of rules, decomposition of compound rules, aggregation of fuzzy rules, fuzzy reasoning, fuzzy inference system, fuzzy expert systems.

Unit IV	**Evolutionary Computing**	**08 Hours**

Basic Evolutionary Processes, EV : A Simple Evolutionary System, Evolutionary Systems as Problem Solvers, A Historical Perspective, Canonical Evolutionary Algorithms - Evolutionary Programming, Evolution Strategies, A Unified View of Simple EAs- A Common Framework, Population Size.

Unit V	Genetic Algorithm	08 Hours

Basic concepts, working principle, procedures of GA, flow chart of GA, Genetic representations, (encoding) Initialization and selection, Genetic operators, Mutation, Generational Cycle, Traditional algorithm vs genetic algorithm, simple GA, general genetic algorithm, schema theorem, Classification of genetic algorithm, Holland classifier systems, genetic programming, applications of genetic algorithm, Convergence of GA. Applications and advances in GA, Differences and similarities between GA and other traditional method, applications.

Unit VI	Swarm Intelligence	08 Hours

Swarm intelligence , Particle Swarm Optimization (PSO) Algorithm- Formulations, Pseudo-code, parameters, premature convergence, topology, biases, Real valued and binary PSO, Ant colony optimization (ACO)- Formulations, Pseudo-code. Applications of PSO and ACO.

Books:

Text:

1. S.N. Sivanandam- "Principles of Soft Computing", Wiley India- ISBN- 9788126527410
2. S. Rajsekaran and G.A. Vijayalakshmi Pai, "Neural Networks, Fuzzy Logic and Genetic Algorithm: Synthesis and Applications" , Prentice Hall of India, ISBN: 0451211243
3. J S R Jang, CT Sun and E.Mizutani, "Neuro-Fuzzy and Soft Computing" , PHI PVT LTD, ISBN 0-13-261066-*3*.
4. De Jong , "Evolutionary Computation: A Unified Approach", Cambridge (Massachusetts): MIT Press. ISBN: 0-262-04194-4. 2006
5. Maurice Clerc, "Particle Swarm Optimization", ISTE, Print ISBN:9781905209040 |Online ISBN:9780470612163 |DOI:10.1002/9780470612163

References:

1. Andries P. Engelbrecht, "Computational Intelligence: An Introduction", 2nd Edition-Wiley India- ISBN: 978-0-470-51250-0
2. N.P.Padhy, "Artificial Intelligence and Intelligent Systems" Oxford University Press, ISBN 10: 0195671546
3. Siman Haykin, "Neural Networks", Prentice Hall of India, ISBN: 0-7923-9475-5
4. Timothy J. Ross, "Fuzzy Logic with Engineering Applications" , Wiley India, ISBN: 978-0-470-74376-8
5. Eiben and Smith, "Introduction to Evolutionary Computation", Springer, ISBN-10: 3642072852

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Savitribai Phule Pune University Fourth Year of Computer Engineering (2015 Course) Elective IV 410253(A): Software Defined Networks		
Teaching Scheme: TH: 03 Hours/Week	**Credit** **03**	**Examination Scheme:** In-Sem (Paper): 30 Marks End-Sem (Paper): 70 Marks

Prerequisite Courses: 310245-Computer Networks

Companion Course: 410255-Laboratory Practice IV

Course Objectives:

- To understand the challenges of the traditional networks and evolution of next generation networks.
- To gain conceptual understanding of Software Defined Networking (SDN) and its role in Data Center.
- To understand role of Open Flow protocol and SDN Controllers.
- To study industrial deployment use-cases of SDN
- To Understand the Network Functions Virtualization and SDN.

Course Outcomes:

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

- Interpret the need of Software Defined Networking solutions.
- Analyze different methodologies for sustainable Software Defined Networking solutions.
- Select best practices for design, deploy and troubleshoot of next generation networks.
- Develop programmability of network elements.
- Demonstrate virtualization and SDN Controllers using OpenFlow protocol

Course Contents		
Unit I	**Introduction to Software Defined Networking (SDN)**	**08 Hours**

Challenges of traditional networks, Traditional Switch Architecture - Control, Data and management Planes, Introduction to SDN, Need of SDN, History of SDN, Fundamental characteristics of SDN (Plane Separation, Simplified Device and Centralized control, Network Automation and Virtualization, and Openness), SDN Operation/Architecture, SDN API's (Northbound API's, Southbound API's, East/West API's), ONF, SDN Devices and SDN Applications.

Unit II	**Open Flow**	**08 Hours**

OpenFlow Overview, The OpenFlow Switch, The OpenFlow Controller, ,OpenFlow Ports, Message Types, Pipeline Processing, Flow Tables, Matching, Instructions, Action Set and List, OpenFlow Protocol, Proactive and Reactive Flow, Timers, OpenFlow Limitations, OpenFlow Advantages and Disadvantages, Open v Switch Features

Unit III	SDN Controllers	08 Hours

SDN OpenFlow Controllers: Open Source Controllers - NOX, POX, Beacon, Maestro, Floodlight, Ryu and Open Daylight, Applicability of OpenFlow protocol in SDN Controllers, Mininet, and implementing software-defined network (SDN) based firewall.

Unit IV	SDN in Data Centre	08 Hours

Data Center Definition, Data Center Demands (Adding, Moving, Deleting Resources, Failure Recovery, Multitenancy, Traffic Engineering and Path Efficiency), Tunneling Technologies for the Data Center, SDN Use Cases in the Data Center, Comparison of Open SDN, Overlays, and APIs, Real-World Data Center Implementations.

Unit V	Network Functions Virtualization (NFV)	08 Hours

Definition of NFV, SDN Vs NFV, In-line network functions, Benefits of Network Functions Virtualization, Challenges for Network Functions Virtualization, Leading NFV Vendors, Comparison of NFV and NV.

Unit VI	SDN Use Cases	08 Hours

Wide Area Networks, Service Provider and Carrier Networks, Campus Networks, Hospitality Networks, Mobile Networks, Optical Networks, SDN vs P2P/Overlay Networks.

Books:

Text:
1. Paul Goransson and Chuck Black, "Software Defined Networks: A Comprehensive Approach", Morgan Kaufmann, 2014, ISBN: 9780124166752, 9780124166844.
2. Siamak Azodolmolky, "Software Defined Networking with Open Flow, Packt Publishing, 2013, ISBN: 9781849698726
3. Thomas D. Nadeau, Ken Gray, "SDN: Software Defined Networks, An Authoritative Review of Network Programmability Technologies", 2013, ISBN : 10:1-4493-4230-2, 978-1-4493-4230-2

References:
1. Vivek Tiwari, "SDN and OpenFlow for Beginners", Digital Services, 2013, ISBN: 10: 1-940686-00-8,   13: 978-1-940686-00-4
2. Fei Hu, "Network Innovation through OpenFlow and SDN: Principles and Design", CRC Press, 2014, ISBN: 10: 1466572094
3. Open Networking Foundation (ONF) Documents, https://www.opennetworking.org, 2015
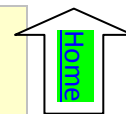
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Savitribai Phule Pune University
Fourth Year of Computer Engineering (2015 Course)
Elective IV
410253(B): Human Computer Interface

Teaching Scheme: TH: 03 Hours/Week	Credit 03	Examination Scheme: In-Sem (Paper): 30 Marks End-Sem (Paper): 70 Marks

Prerequisite Courses: 210251-Computer Graphics

Companion Course: 410255-Laboratory Practice IV

Course Objectives:

- To design, implement and evaluate effective and usable Human Computer Interfaces.
- To describe and apply core theories, models and methodologies from the field of HCI.
- Learn a variety of methods for evaluating the quality of a user interface
- To implement simple graphical user interfaces based on principles of HCI.

Course Outcomes:

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

- Evaluate the basics of human and computational abilities and limitations.
- Inculcate basic theory, tools and techniques in HCI.
- Apply the fundamental aspects of designing and evaluating interfaces.
- Apply appropriate HCI techniques to design systems that are usable by people

Course Contents

Unit I	Foundations of Human–Computer Interaction	08 Hours

What is HCI – design, models, evaluation, Need to understand people, computers and methods. Basic human abilities - vision, hearing, touch, memory.

Computers – speed, interfaces, widgets, and effects on interaction. Humans – Memory, Attention Span, Visual Perception, psychology, ergonomics. Understanding Users.

Methods for evaluation of interfaces with users: goals of evaluation, approaches, ethics, introspection, extracting the conceptual model, direct observation, constructive interaction, interviews and questionnaires, continuous evaluation via user feedback and field studies, choosing an evaluation method.

Unit II	The Design Process	08 Hours

Interaction Design Basics, Interaction Styles. HCI in the Software Process. HCI design principles and rules: design principles, principles to support usability, golden rules and heuristics, HCI patterns, design rules, HCI design standards. Direct Manipulation - Overview, Scope, Applications. Universal Design, User-centered design, task analysis/GOMS, Graphic Design

Unit III	Implementation	08 Hours

Implementation Tools, Technology and change designing for the Web, designing for portable devices. Handling errors and Designing Help. Prototyping and UI Software.

Unit IV	Evaluation and User Support	08 Hours

Evaluation of User Interfaces. Web Browsers - Fonts, Color Palette, Color Depth, Resolution, Layout, Size, Orientation. Mobile devices issues – design, limitations, what next. User Support.

Unit V	Users Models	08 Hours

Predictive Models, Cognitive Models. Interaction with Natural Languages, Next Generation Interface. Socio-organizational Issues and Stakeholder Requirements. Heuristic Evaluation, Evaluation with Cognitive Models, Evaluation with Users.

Unit VI	Task Models and Dialogs	08 Hours

Task Analysis, DOET (Design of Everyday Things). Design Dialogs Notations, Warnings, and Error messages. Model-based Evaluation. User Testing, Usability Testing, User Acceptance Testing.
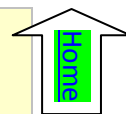
Books:

Text:
1. Alan J, Dix. Janet Finlay, Rusell Beale, "Human Computer Interaction", Pearson Education, 3rd Edition, 2004, ISBN 81-297-0409-9
2. Jenny Preece, Rogers, Sharp, "Interaction Design-beyond human-computer interaction", WILEY-INDIA, ISBN 81-265-0393-9

References:
3. Jonathan Lazar, Jinjuan Feng, Harry Hochheiser, "Research Methods in Human-Computer Interaction", Third Edition, Morgan Kaufmann, 2017, ISBN: 9780128053904.
4. Mary Beth Rosson and John M. Carroll, "Usability Engineering: Scenario-Based Development of Human-Computer Interaction", Morgan Kaufmann, 2001, ISBN-13**:** 978-1558607125

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Savitribai Phule Pune University
Fourth Year of Computer Engineering (2015 Course)
Elective IV
410253(C): Cloud Computing

Teaching Scheme: TH: 03 Hours/Week	Credit 03	Examination Scheme: In-Sem (Paper): 30 Marks End-Sem (Paper): 70 Marks

Prerequisite Courses: 310245 Computer Networks

Companion Course: 410255-Laboratory Practice IV

Course Objectives:
- To understand cloud computing concepts;
- To study various platforms for cloud computing
- To explore the applications based on cloud computing

Course Outcomes:
On completion of the course, student will be able to–
- To install cloud computing environments.
- To develop any one type of cloud
- To explore future trends of cloud computing

Course Contents

Unit I	Basics of Cloud Computing	08 Hours

Overview, Applications, Intranets and the Cloud. Your Organization and Cloud Computing- Benefits, Limitations, Security Concerns. Software as a Service (SaaS)- Understanding the Multitenant Nature of SaaS Solutions, Understanding SOA.   Platform as a Service (PaaS)-IT Evolution Leading to the Cloud, Benefits of Paas Solutions, Disadvantages of PaaS Solutions.   Infrastructure as a Service (IaaS)-Understanding IaaS, Improving Performance through Load Balancing, System and Storage Redundancy, Utilizing Cloud-Based NAS Devices, Advantages, Server Types. Identity as a Service (IDaaS).

Unit II	Data Storage and Security in Cloud	08 Hours

Cloud file systems: GFS and HDFS, BigTable, HBase and Dynamo Cloud data stores: Datastore and Simple DB Gautam Shrauf, Cloud Storage-Overview, Cloud Storage Providers. [Anthony T. Velte]3 Securing the Cloud- General Security Advantages of Cloud-Based Solutions, Introducing Business Continuity and Disaster Recovery. Disaster Recovery- Understanding the Threats.

Unit III	Virtualization	08 Hours

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. 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), Standards for Security.

Unit IV	Amazon Web Services	08 Hours

Services offered by Amazon Hands-on Amazon, EC2 - Configuring a server, Virtual Amazon Cloud, AWS Storage and Content Delivery Identify key AWS storage options Describe Amazon EBS Creating an Elastic Block Store Volume Adding an EBS Volume to an Instance Snap shotting an EBS Volume and Increasing Performance Create an Amazon S3 bucket and manage associated objects. AWS Load Balancing Service Introduction Elastic Load Balancer Creating and Verifying Elastic Load Balancer.

Unit V	Ubiquitous Clouds and the Internet of Things	08 Hours

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.

Unit VI	Future of Cloud Computing	08 Hours

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.

Books:

Text:

1. Anthony T. Velte Toby J. Velte, Robert Elsenpeter, "Cloud Computing: A Practical Approach", 2010, The McGraw-Hill.
2. Dr. Kris Jamsa, " Cloud Computing: SaaS, PaaS, IaaS, Virtualization and more" , Wiley Publications, ISBN: 978-0-470-97389-9
3. Gautam Shrof, "ENTERPRISE CLOUD COMPUTING Technology Architecture, Applications, Cambridge University Press, ISBN: 9780511778476

References:

1. Dr. Kumar Saurabh,"Cloud Computing", Wiley Publication, ISBN10: 8126536039
2. Buyya, "Mastering Cloud Computing", Tata McGraw Hill, ISBN-13: 978-1-25-902995-0,
3. Barrie Sosinsky,"Cloud Computing", Wiley India, ISBN: 978-0-470-90356-8
4. Kailash Jayaswal, "Cloud computing", Black Book, Dreamtech Press
5. Thomas Erl, Zaigham Mahmood and Ricardo Puttini, "Cloud Computing: Concepts, Technology and Architecture", Pearson, 1st Edition, ISBN :978   9332535923, 9332535922
4. Tim Mather, Subra K, Shahid L.,Cloud Security and Privacy, Oreilly, ISBN-13 978-81-8404-815-5
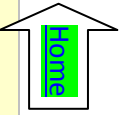
Savitribai Phule Pune University
Fourth Year of Computer Engineering (2015 Course)
Elective IV
410253(D): Open Elective

Teaching Scheme:	Credit	Examination Scheme:
TH: 03 Hours/Week	03	In-Sem (Paper): 30 Marks End-Sem (Paper): 70 Marks

Companion Course: 410255-Laboratory Practice IV

The open elective included, so as to give the student a wide choice of subjects from other Engineering Programs. To inculcate the out of box thinking and to feed the inquisitive minds of the learners the idea of open elective is need of the time.

Flexibility is extended with the choice of open elective allows the learner to choose interdisciplinary/exotic/future technology related courses to expand the knowledge horizons.

With this idea learner opts for the course without any boundaries to choose the approved by academic council and Board of Studies.

Savitribai Phule Pune University
Fourth Year of Computer Engineering (2015 Course)
410254:Laboratory Practice III

Teaching Scheme:	Credit	Examination Scheme:
Practical : 04 Hours/Week	**02**	**Term Work: 50 Marks** **Practical: 50 Marks**

Companion Courses: 410250 and 410251

Course Objectives and Outcomes: Practical hands on is the absolute necessity as far as employability of the learner is concerned. The presented course is solely intended to enhance the competency by undertaking the laboratory assignments of the core courses.

About

Laboratory Practice III is for practical hands on for core courses Machine Learning and Information & Cyber Security.

Guidelines for Laboratory Conduction

- **List of recommended programming assignments and sample mini-projects is provided for reference.**
- Referring these, Course Teacher or Lab Instructor may frame the assignments/mini-project by understanding the prerequisites, technological aspects, utility and recent trends related to the respective courses.
- Preferably there should be multiple sets of assignments/mini-project and distribute among batches of students.
- Real world problems/application based assignments/mini-projects create interest among learners serving as foundation for future research or startup of business projects.
- Mini-project can be completed in group of 2 to 3 students.
- Software Engineering approach with proper documentation is to be strictly followed.
- Use of open source software is to be encouraged.
- Instructor may also set one assignment or mini-project that is suitable to respective course beyond the scope of syllabus.

Operating System recommended :-   64-bit Open source Linux or its derivative

Programming Languages: C++/JAVA/PYTHON/R

Programming tools recommended: Front End: Java/Perl/PHP/Python/Ruby/.net, Backend : MongoDB/MYSQL/Oracle, Database Connectivity : ODBC/JDBC, Additional Tools: Octave, Matlab, WEKA**.**

Guidelines for Student Journal

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

As a conscious effort and little contribution towards Green IT and environment awareness, attaching printed papers as part of write-ups and program listing to journal may be avoided. Use of digital storage media/DVD containing students programs maintained by lab In-charge is highly encouraged. For reference one or two journals may be maintained with program prints at Laboratory.

Guidelines for Assessment

Continuous assessment of laboratory work is to be 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 **reserving weightage for successful mini-project completion and related documentation.**

Guidelines for Practical Examination

- Both internal and external examiners should jointly frame suitable problem statements for practical examination based on the term work completed.
- During practical assessment, the expert evaluator should give the maximum weightage to the satisfactory implementation of the problem statement.
- The supplementary and relevant questions may be asked at the time of evaluation to test the student's for advanced learning, understanding of the fundamentals, effective and efficient implementation.
- Encouraging efforts, transparent evaluation and fair approach of the evaluator will not create any uncertainty or doubt in the minds of the students. So adhering to these principles will consummate our team efforts to the promising boost to the student's academics.

Guidelines for Instructor's Manual

The instructor's manual is to be developed as a hands-on resource and as ready reference. The instructor's manual need to include prologue (about University/program/ institute/ department/foreword/ preface etc), University syllabus, conduction and Assessment guidelines, topics under consideration-concept, objectives, outcomes, set of typical applications/assignments/ guidelines, references among others.

Suggested List of Laboratory Assignments& Mini Projects

(any 04 assignments Machine Learning and Information & Cyber Security AND Mini-project per course)

410250: Machine Learning

1.	**Assignment on Linear Regression:** The following table shows the results of a recently conducted study on the correlation of the number of hours spent driving with the risk of developing acute backache. Find the equation of the best fit line for this data.

Number of hours spent driving (x)	Risk score on a scale of 0-100 (y)
10	95
9	80
2	10
15	50
10	45
16	98
11	38
16	93

|	
2.	**Assignment on Decision Tree Classifier:** A dataset collected in a cosmetics shop showing details of customers and whether or not they responded to a special offer to buy a new lip-stick is shown in table below. Use this dataset to

build a decision tree, with Buys as the target variable, to help in buying lip-sticks in the future. Find the root node of decision tree. According to the decision tree you have made from previous training data set, what is the decision for the test data: [Age < 21, Income = Low, Gender = Female, Marital Status = Married]?

ID	Age	Income	Gender	Marital Status	Buys
1	< 21	High	Male	Single	No
2	< 21	High	Male	Married	No
3	21-35	High	Male	Single	Yes
4	>35	Medium	Male	Single	Yes
5	>35	Low	Female	Single	Yes
6	>35	Low	Female	Married	No
7	21-35	Low	Female	Married	Yes
8	< 21	Medium	Male	Single	No
9	<21	Low	Female	Married	Yes
10	> 35	Medium	Female	Single	Yes
11	< 21	Medium	Female	Married	Yes
12	21-35	Medium	Male	Married	Yes
13	21-35	High	Female	Single	Yes
14	> 35	Medium	Male	Married	No

3. **Assignment on k-NN Classification:**
In the following diagram let blue circles indicate positive examples and orange squares indicate negative examples. We want to use k-NN algorithm for classifying the points. If k=3, find the class of the point (6,6). Extend the same example for Distance-Weighted k-NN and Locally weighted Averaging
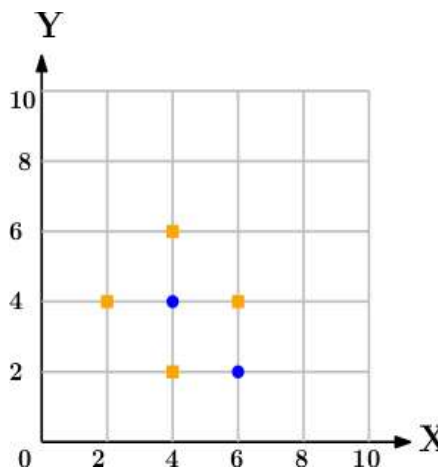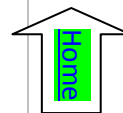

4. **Assignment on K-Means Clustering:**
We have given a collection of 8 points. P1=[0.1,0.6] P2=[0.15,0.71] P3=[0.08,0.9] P4=[0.16, 0.85] P5=[0.2,0.3] P6=[0.25,0.5] P7=[0.24,0.1] P8=[0.3,0.2]. Perform the k-mean clustering with initial centroids as   m1=P1 =Cluster#1=C1 and m2=P8=cluster#2=C2. Answer the following
1] Which cluster does P6 belongs to?
2] What is the population of cluster around m2?
3] What is updated value of m1 and m2?

5. **Mini-Project 1** on Genetic Algorithm:
Apply the Genetic Algorithm for optimization on a dataset obtained from UCI ML repository.
For Example: IRIS Dataset or Travelling Salesman Problem or KDD Dataset

6.	**Mini-Project 2** on SVM: Apply the Support vector machine for classification on a dataset obtained from UCI ML repository. For Example: Fruits Classification or Soil Classification or Leaf Disease Classification
7.	**Mini-Project 3** on PCA: Apply the Principal Component Analysis for feature reduction on any Company Stock Market Dataset
	410251:: : Information and Cyber Security
1.	Implementation of S-DES
2.	Implementation of S-AES
3.	Implementation of Diffie-Hellman key exchange
4.	Implementation of RSA.
5.	Implementation of ECC algorithm.
6.	**Mini Project 1:** SQL Injection attacks and Cross -Site Scripting attacks are the two most common attacks on web application. Develop a new policy based Proxy Agent, which classifies the request as a scripted request or query based request, and then, detects the respective type of attack, if any in the request. It should detect both SQL injection attack as well as the Cross-Site Scripting attacks.
7.	**Mini Project 2:**This task is to demonstrate insecure and secured website. Develop a web site and demonstrate how the contents of the site can be changed by the attackers if it is http based and not secured. You can also add payment gateway and demonstrate how money transactions can be hacked by the hackers. Then support your website having https with SSL and demonstrate how secured website is.
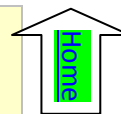
Savitribai Phule Pune University
Fourth Year of Computer Engineering (2015 Course)
410255:Laboratory Practice IV

Teaching Scheme: Practical : 04 Hours/Week	Credit 02	Examination Scheme: Term Work: 50 Marks Presentation: 50 Marks

Companion Courses: 410252 and 410253

Course Objectives and Outcomes: Practical hands on is the absolute necessity as far as employability of the learner is concerned. The presented course is solely intended to enhance the competency by undertaking the laboratory assignments of the elective courses. Enough choice is provided to the learner to choose an elective of one's interest.

Laboratory Practice II is companion lab for elective course III and elective course IV.

Guidelines for Laboratory Conduction

- **List of recommended programming assignments and sample mini-projects is provided for reference.**
- Referring these, Course Teacher or Lab Instructor may frame the assignments/mini-project by understanding the prerequisites, technological aspects, utility and recent trends related to the respective courses.
- Preferably there should be multiple sets of assignments/mini-project and distribute among batches of students.
- Real world problems/application based assignments/mini-projects create interest among learners serving as foundation for future research or startup of business projects.
- Mini-project can be completed in group of 2 to 3 students.
- Software Engineering approach with proper documentation is to be strictly followed.
- Use of open source software is to be encouraged.
- Instructor may also set one assignment or mini-project that is suitable to respective course beyond the scope of syllabus.

Operating System recommended :- 64-bit Open source Linux or its derivative

Programming Languages: C++/JAVA/PYTHON/R

Programming tools recommended: Front End: Java/Perl/PHP/Python/Ruby/.net, Backend : MongoDB/MYSQL/Oracle, Database Connectivity : ODBC/JDBC, Additional Tools: Octave, Matlab, WEKA.

Guidelines for Student Journal

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

As a conscious effort and little contribution towards Green IT and environment awareness, attaching printed papers as part of write-ups and program listing to journal may be avoided. Use of digital storage media/DVD containing students programs maintained by lab In-charge is highly encouraged. For reference one or two journals may be maintained with program prints at Laboratory.

Guidelines for Assessment

Continuous assessment of laboratory work is to be done based on overall performance and lab

Home

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 **reserving weightage for successful mini-project completion and related documentation.**

Guidelines for Practical Examination

- **It is recommended to conduct examination based on Mini-Project(s) Demonstration and related skill learned.** Team of 2 to 3 students may work on mini-project. During the assessment, the expert evaluator should give the maximum weightage to the satisfactory implementation and software engineering approach followed.
- The supplementary and relevant questions may be asked at the time of evaluation to test the student's for advanced learning, understanding, effective and efficient implementation and demonstration skills.
- Encouraging efforts, transparent evaluation and fair approach of the evaluator will not create any uncertainty or doubt in the minds of the students. So adhering to these principles will consummate our team efforts to the promising start of the student's academics.

Guidelines for Instructor's Manual

The instructor's manual is to be developed as a hands-on resource and as ready reference. The instructor's manual need to include prologue (about University/program/ institute/ department/foreword/ preface etc), University syllabus, conduction and Assessment guidelines, topics under consideration-concept, objectives, outcomes, set of typical applications/assignments/ guidelines, references among others.

Suggested List of Laboratory Assignments & Mini Projects

Recommended / Sample set of assignments and mini projects for reference for four courses offered for Elective I and for four courses offered for Elective II. Respective Student have to complete laboratory work for elective I and II that he/she has opted.
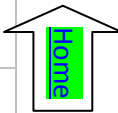
410252: Elective III

410252 (A) Advanced Digital Signal Processing

Use -
A] MATLAB or other equivalent software working with speech and image signals/files and for analysis purpose.
B] C++ or JAVA for working with sampled data (n – point data samples of DT/Digital signal)
C] JAVA or other for image processing assignments

| 1.	Apply 1-D DFT to observe spectral leakage and frequency analysis of different window sequences, plot the frequency spectrums.
2.	Adaptive FIR and IIR filter design: A] Steepest descent and Newton method, LMS method, B] Adaptive IIR Filter design: Pade Approximation, Least square design
3.	Power spectrum estimation and analysis: Take a speech signal and perform A] Non parametric method: DFT and window sequences B] Parametric methods: AR model parameters
4.	Multi-rate DSP and applications – Decimation, Interpolation, sampling rate conversion A] Take a speech signal with specified sampling frequency. Decimate by factor D(e.g. factor B] Take a speech signal with specified sampling frequency. Interpolate by factor I(e.g. factor)

	C] Sampling rate conversion by factor of I/D
5.	Write a program to calculate LPC coefficients, reflection coefficients using Levinson Durbin algorithm
6.	Feature Extraction of speech signal A] Using LPC and other methods B] Apply different coding methods: harmonic coding, vector quantization
7.	**Mini-Project 1:** Discrete Cosine Transform (DCT) A] To find DCT of NxN image block B] To plot spectrum of the speech signal using DCT and find the correlation of DCT transformed signal C] Image filtering using DCT : LPF, edge detection D] Image compression using DCT, Image resizing
8.	**Mini-Project 2:** Wavelet Transform (WT) A] To get compression using wavelet decomposition of a signal B] Denoising using wavelet decomposition C] To get compression using wavelet decomposition of a signal (Harr Wavelet) D] To get low-pass filtered and high pass filtered speech signal using Haar wavelet E] Image filtering using WT
9.	**Mini-Project 3:** Image Processing A] Histogram and Equalization B] Image Enhancement Techniques C] Image Filtering: LPF, HPF, Sobel/Prewitt Masks D] Image Smoothing with special filters: Median, Weiner, Homomorphic filters
Course: 410252 (B) Compiler Construction
1.	Implement a Lexical Analyzer using LEX for a subset of C. Cross check your output with Stanford LEX.
2.	Implement a parser for an expression grammar using YACC and LEX for the subset of C. Cross check your output with Stanford LEX and YACC.
3.	Generate and populate appropriate Symbol Table.
4.	Implementation of Semantic Analysis Operations (like type checking, verification of function parameters, variable declarations and coercions) possibly using an Attributed Translation Grammar.
5.	Implement the front end of a compiler that generates the three address code for a simple language.
6.	A Register Allocation algorithm that translates the given code into one with a fixed number of registers.
7.	Implementation of Instruction Scheduling Algorithm.
8.	Implement Local and Global Code Optimizations such as Common Sub-expression Elimination, Copy Propagation, Dead-Code Elimination, Loop and Basic-Block Optimizations. (Optional)
9.	**Mini-Project 1:** Implement POS tagging for simple sentences written Hindi or any Indian Language
Course: 410252 (C) Embedded and Real Time Operating Systems
1.	Simulation/ Design, planning and modeling of a Real-Time / Embedded System for- (any one) - Alarm system for elderly people (Fall detection, Heart attack) - Medication machine for patients in ICU - Smart traffic control - Autonomous car - Smart home (sound system, temperature, light)
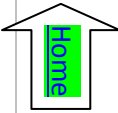
	• Control of an autonomous quadrocopter (e.g. for surveillance tasks) • Control of a rail station • Video conference system • Washing machine
Course: 410252 (D) Soft Computing and Optimization Algorithms
1.	Implement Union, Intersection, Complement and Difference operations on fuzzy sets. Also create fuzzy relation by Cartesian product of any two fuzzy sets and perform max-min composition on any two fuzzy relations.
2.	Implement genetic algorithm for benchmark function (eg. Square, Rosenbrock function etc) Initialize the population from the Standard Normal Distribution. Evaluate the fitness of all its individuals. Then you will do multiple generation of a genetic algorithm. A generation consists of applying selection, crossover, mutation, and replacement. Use: • Tournament selection without replacement with tournament size s • One point crossover with probability Pc • bit-flip mutation with probability Pm • use full replacement strategy
3.	Implement Particle swarm optimization for benchmark function (eg. Square, Rosenbrock function). Initialize the population from the Standard Normal Distribution. Evaluate fitness of all particles. Use : • c1=c2 = 2 • Inertia weight is linearly varied between 0.9 to 0.4. • Global best variation
4.	Implement basic logic gates using Mc-Culoch-Pitts or Hebbnet neural networks
5.	Write a program to find the Boolean function to implement following single layer perceptron. Assume all activation functions to be the threshold function which is 1 for all input values greater than zero and 0, otherwise. X b=? $W_1=1$ $W_2=1$ A B
6.	Implement Union, Intersection, Complement and Difference operations on fuzzy sets. Also create fuzzy relation by Cartesian product of any two fuzzy sets and perform max-min composition on any two fuzzy relations.
7.	The figure shows a single hidden layer neural network. The weights are initialized to 1's as shown in the diagram and all biases are initialized to 0's. Assume all the neurons have linear activation functions. The neural network is to be trained with stochastic (online) gradient descent. The first training example is [x1=1, x2=0] and the desired output is 1. Design the back-propagation algorithm to find the updated value for W11 after backpropagation. Choose the value that is the closest to the options given below: [learning rate =0.1]
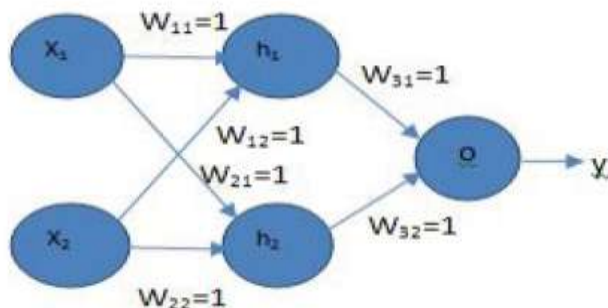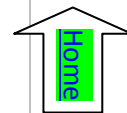
8.	**Mini-Project 1** on Genetic Algorithm: Apply the Genetic Algorithm for optimization on a dataset obtained from UCI ML repository. For Example: IRIS Dataset or Travelling Salesman Problem or KDD Dataset
9.	Apply the Particle swarm optimization for Travelling Salesman Problem
10.	**Mini-Project 2** on Fuzzy Logic: Solve Greg Viot's fuzzy cruise controller using MATLAB Fuzzy logic toolbox or Octave or Python.
11.	**Mini-Project 3** on Fuzzy Logic: Solve Air Conditioner Controller using MATLAB Fuzzy logic toolbox or Octave or Python.

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410253: Elective III

Course: 410253 (A) Software Defined Networks

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1.	Phase I:Set up Mininet network emulation environment using Virtual Box and Mininet. Demonstrate the basic commands in Mininet and emulate different custom network topology (Simple, Linear, and Tree).View flow tables.
2.	Phase II:Study open source POX and Floodlight controller. Install controller and run custom topology using remote controller like POX and floodlight controller. Identify inserted flows by the controllers.
3.	Phase III:Create a SDN environment on Mininet and configure a switch to provide a firewall functionality using POX controller. Ref:https://github.com/mininet/openflow-tutorial/wiki/Create- Firewall
4.	Phase IV:Build your own Internet Router using Mininet as an Emulator and POX controller. Write a simple router with a static routing table. The router will receive raw Ethernet frames. It will process the packets just like a real router, and then forward them to the correct outgoing interface. Make sure you receive the Ethernet frame and create the forwarding logic so packets go to the correct interface. Ref:https://github.com/mininet/mininet/wiki/Simple-Router
5.	Phase V: Emulate a Data Center and manage it via a Cloud Network Controller: create a multi-rooted tree-like (Clos) topology in Mininet to emulate a data center. Your second task is to implement specific SDN applications on top of the network controller in order to orchestrate multiple network tenants within a data center environment, in the context of network virtualization and management. Ref: https://opencourses.uoc.gr/courses/pluginfile.php/13576/mod_resource/content/2/exercise5.pdf

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Course:410253 (B) Human Computer Interface

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| 1.	Identify specialized users and related facilities for a selected product / system and make necessary suggestions for its improved accessibility design.

2.	Design user persona for the users of selected product / system.
3.	Conduct a contextual inquiry for selected product / system.
4.	Design an interface prototype for selected product / system.
5.	Evaluate an interface using usability evaluation technique.

	Course: 410253 (C) Cloud Computing
1.	1. Installation and configuration of own Cloud 2. Implementation of Virtualization in Cloud Computing to Learn Virtualization Basics, Benefits of Virtualization in Cloud using Open Source Operating System. 3. Study and implementation of infrastructure as Service using Open Stack. 4. Write a program for Web feed using PHP and HTML. 5. Write a Program to Create, Manage and groups User accounts in own Cloud by Installing Administrative Features. 6. Case study on Amazon EC2 to learn about Amazon EC2,Amazon Elastic Compute Cloud is a central part of Amazon.com's cloud computing platform, Amazon Web Services. How EC2 allows users torrent virtual computers on which to run their own computer applications. 7. Case study on Microsoft azure to learn about Microsoft Azure is a cloud computing platform and infrastructure, created by Microsoft, forbuilding, deploying and managing applications and services through a global network of Microsoft-managed datacenters. How it work, different services provided by it. 8. Design and develop custom Application (Mini Project) using Salesforce Cloud. 9. Assignment to install and configure Google App Engine. 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. 11. Creating an Application in SalesForce.com using Apex programming Language. **12.** Design an Assignment based on Working with Mangrasoft Aneka Software.
2.	**Mini-Project 1:** Setup your own cloud for Software as a Service (SaaS) over the existing LAN in your laboratory. In this assignment you have to write your own code for cloud controller using open source technologies **without HDFS**. Implement the basic operations may be like to upload and download file on/from cloud in encrypted form.
3.	**Mini-Project 2:** Setup your own cloud for Software as a Service (SaaS) over the existing LAN in your laboratory. In this assignment you have to write your own code for cloud controller using open source technologies to implement **with HDFS**. Implement the basic operations may be like to divide the file in segments/blocks and upload/ download file on/from cloud in encrypted form.
	Course: 410253 (D) Open Elective
	Suitable set of programming assignments/Mini-projects for open elective Opted.
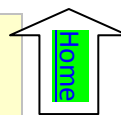
Savitribai Phule Pune University
Fourth Year of Computer Engineering (2015 Course)
410256:Project Work Stage II

Teaching Scheme: Practical : 06 Hours/Week	Credit 06	Examination Scheme: Term Work: 100 Marks Presentation: 50 Marks

Course Objectives:

- To follow SDLC meticulously and meet the objectives of proposed work
- To test rigorously before deployment of system
- To validate the work undertaken
- To consolidate the work as furnished report.

Course Outcomes:

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

- Show evidence of independent investigation
- Critically analyze the results and their interpretation.
- Report and present the original results in an orderly way and placing the open questions in the right perspective.
- Link techniques and results from literature as well as actual research and future research lines with the research.
- Appreciate practical implications and constraints of the specialist subject

Guidelines

In Project Work Stage–II, the student shall complete the remaining project work which consists of Selection of Technology and Tools, Installations, UML implementations, testing, Results, performance discussions using data tables per parameter considered for the improvement with existing/known algorithms/systems and comparative analysis and validation of results and conclusions. The student shall prepare and submit the report of Project work in standard format for satisfactory completion of the work that is the duly certified by the concerned guide and head of the Department/Institute.

Follow guidelines and formats as mentioned in Project Workbook recommended by Board of Studies.

Savitribai Phule Pune University
Fourth Year of Computer Engineering (2015 Course)
410257: Audit Course 6

In addition to credits, it is recommended that there should be audit course in preferably in each semester from second year to supplement their knowledge and skills. Student will be awarded the bachelor's degree if he/she earns 190 credits and clears all the audit courses specified in the syllabus. The student will be awarded grade as AP on successful completion of audit course. The student may opt for one of the audit courses per semester, starting in second year first semester. Though not mandatory, such a selection of the audit courses helps the learner to explore the subject of interest in greater detail resulting in achieving the very objective of audit course's inclusion. List of options offered is provided. Each student has to choose one audit course from the list per semester. Evaluation of audit course will be done at institute level itself. Method of conduction and method of assessment for audit courses are suggested.

Criteria:

The student registered for audit course shall be awarded the grade AP (Audit Course Pass) and shall be included such AP grade in the Semester grade report for that course, provided student has the minimum attendance as prescribed by the Savitribai Phule Pune University and satisfactory in-semester performance and secured a passing grade in that audit course. No grade points are associated with this 'AP' grade and performance in these courses is not accounted in the calculation of the performance indices SGPA and CGPA. Evaluation of audit course will be done at institute level itself. (Ref- http://www.unipune.ac.in/Syllabi_PDF/revised-2015/engineering/UG_RULE_REGULATIONS_FOR_CREDIT_SYSTEM-2015_18June.pdf)

Guidelines for Conduction and Assessment(Any one or more of following but not limited to)

- Lectures/ Guest Lectures
- Visits (Social/Field) and reports
- Demonstrations
- Surveys
- Mini Project
- Hands on experience on specific focused topic

Guidelines for Assessment (Any one or more of following but not limited to)

- Written Test
- Demonstrations/ Practical Test
- Presentations
- IPR/Publication
- Report

Audit Course 3 Options

AC6- I	Business Intelligence
AC6-II	Gamification
AC6-III	Quantum Computing
AC6-IV	Usability Engineering
AC6-V	Conversational Interfaces
AC6-VI	MOOC- Learn New Skills (Refer Page 48)

Note: It is permitted to opt one of the audit courses listed at SPPU website too, if not opted earlier
http://collegecirculars.unipune.ac.in/sites/documents/Syllabus%202017/Forms/AllItems.aspx
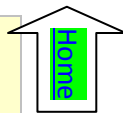
Savitribai Phule Pune University, Pune
Fourth Year of Computer Engineering (2015 Course)
410257: Audit Course 6
AC6 – I: Business Intelligence

The course aims at examining Business Intelligence (BI) as a broad category of applications and technologies for gathering, storing, analyzing, sharing and providing access to data to help enterprise users make better managerial decisions.

Course Objectives:
- To understand the concept of Business Intelligence
- To know the details of Decision Support System
- To inculcate the concepts of Data Warehousing
- To understand the basics of design and management of BI systems

Course Outcome:
On completion of the course, learner will be able to–
- Apply the concepts of Business Intelligence in real world applications
- Explore and use the data warehousing wherever necessary
- 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. Decision Making Concepts : 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. Data-Warehouse : Introduction: Data warehouse Modeling, data warehouse design, data-warehouse technology, Distributed data warehouse, and materialized view

4.Data Pre-processing and outliers: Data Analytics life cycle, Discovery, Data preparation, Preprocessing requirements, data cleaning, data integration, data reduction, data transformation, Data discretization, and concept hierarchy generation, Model Planning, Model building, Communicating Results and Findings, Operationalizing, Introduction to OLAP. Real-world Applications, types of outliers, outlier challenges, Outlier detection Methods, Proximity-Based Outlier analysis, Clustering Based Outlier analysis.

5.Designing and managing BI systems : Determining infrastructure requirements, planning for scalability and availability, managing and maintenance of BI systems, managing BI operations or business continuity

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.

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

Savitribai Phule Pune University, Pune
Fourth Year of Computer Engineering (2015 Course)
410257: Audit Course 6
AC6 – II: Gamification

Gamification is the application of game-design elements and game principles in non-game contexts. Gamification commonly employs game design elements to improve user engagement, organizational productivity, flow, crowd sourcing, employee recruitment and evaluation, ease of use, usefulness of systems, exercise, traffic violations, voter apathy, and more.

Course Objectives:

- To develop problem solving abilities using gamification
- To apply gamifications for Web Applications
- To apply gamifications for Mobile Applications

Course Outcome:

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

- To write survey on the gamification paradigms.
- To write programs to solve problems using gamification and open source tools.
- To solve problems for multi-core or distributed, concurrent/Parallel environments

Course Contents:

1. **Gaming Foundations:** Introduction, Resetting Behavior, Replaying History, Gaming foundations: Fun Quotient, Evolution by loyalty, status at the wheel, the House always wins.

2. **Developing Thinking:** Re-framing Context, Player Motivation, Case studies for Thinking: Tower of Hanoi.

3. **Opponent Moves in Gamification:** Reclaiming Opposition, Gamed Agencies, Remodeling design, Game Mechanics, Case study of Maze Problem.

4. **Game Design:** Game Mechanics and Dynamics: Feedback and Re-enforcement, Game Mechanics in depth, putting it together, Case study of 8 queens problem.

5. **Advanced tools, techniques and applications:** Gamification case Studies, Coding basic game Mechanics, Instant Gamification Platforms, Mambo.io(Ref:http://mambi.io), Installation and use of BigDoor (Open Source http://bigdoor.com),ngageoint/gamification-server (ref: https://github.com/ngageoint/gamification-server

Books:

1. Mathias Fuchs, Sonia Fizek,Paolo Ruffino, Niklas Schrape, Rethinking Gamification, Meson Press, ISBN (Print): 978-3-95796-000-9 , http://projects.digital-cultures.net/meson-press/files/2014/06/9783957960016-rethinking-gamification.pdf, ISBN (PDF): 978-3-95796-001-6,

2. , Gabe Zechermann, Christopher Cunningham, Gamification Design, Oreilly, ISBN: 978-1-449-39767-8, ftp://ftp.ivacuum.ru/i/WooLF/%B2011%5D%20Gamification%20by%20Design.pdf

3. http://press.etc.cmu.edu/files/MobileMediaLearning-DikkersMartinCoulter-web.pdf

Savitribai Phule Pune University, Pune
Fourth Year of Computer Engineering (2015 Course)
410257: Audit Course 6
AC6 – III: Quantum Computing

Quantum computation and quantum information is the study of the information processing tasks that can be accomplished using quantum mechanical systems. Sounds pretty simple and obvious, doesn't it? Like many simple but profound ideas it was a long time before anybody thought of doing information processing using quantum mechanical sys- tems. To see why this is the case, we must go back in time and look in turn at each of the fields which have contributed fundamental ideas to quantum computation and quantum information -quantum mechanics, computer science, information theory, and cryptography.

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
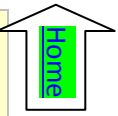
Savitribai Phule Pune University, Pune
Fourth Year of Computer Engineering (2015 Course)
410257: Audit Course 6
AC6 – IV: Usability Engineering

In this course you will have a hands-on experience with usability evaluation and user-centered design. This course will not help to learn how to implement user interfaces, but rather how to design based on the needs of users, which you will determine, and learn how toevaluate your designs rigorously. This help in knowing more about the usability; human computer interaction, the psychological aspects of computing, evaluation.

Course Objectives:

- To understand the human centered design process and usability engineering process and their roles in system design and development.
- To know usability design guidelines, their foundations, assumptions, advantages, and weaknesses
- Understand the user interface based on analysis of human needs and prepare a prototype system

Course Outcome:

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

- Describe the human centered design process and usability engineering process and their roles in system design and development.
- Discuss usability design guidelines, their foundations, assumptions, advantages, and weaknesses.
- Design a user interface based on analysis of human needs and prepare a prototype system.
- Assess user interfaces using different usability engineering techniques.
- Present the design decisions

Course Contents:

1. Introduction: Usability and Other Considerations, Definition of Usability, Example: Measuring the Usability of Icons, Usability Trade-Offs, Categories of Users and Individual User Differences
2. Usability in Software Development : The Emergence of Usability, Human Computer Interaction, Usability Engineering
3. The usability Engineering Lifecycle: Requirement Analysis, Design, Testing, Development
4. Usability Assessment Methods beyond Testing
5. International User Interfaces

Books:

1. Mary Beth Rosson, John Millar Carroll, "Usability Engineering: Scenario- based Development of Human- Computer Interaction"
2. Jakob Nielsen, "Usability Engineering"
1. Deborah J. Mayhew, " The usability engineering lifecycle"
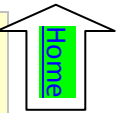
Home

Savitribai Phule Pune University, Pune
Fourth Year of Computer Engineering (2015 Course)
410257: Audit Course 6
AC6 – V: Conversational Interfaces

Effective information security at the enterprise level requires participation, planning, and practice. It is an ongoing effort that requires management and staff to work together from the same script. Fortunately, the information security community has developed a variety of resources, methods, and best practices to help modern enterprises address the challenge. Unfortunately, employing these tools demands a high degree of commitment, understanding, and skill attributes that must be sustained through constant awareness and training.

Course Objectives:
- To understand the basics of conversation
- To know the interactive environments for conversational skills
- To acquaint with the speech to text and text to speech techniques

Course Outcome:

On completion of the course, learner will be able to–
- Develop an effective interface for conversation
- Explore advanced concepts in user interface

Course Contents:

1. **Introduction to Conversational Interface:** Preliminaries, Developing a speech based Conversational Interface, Conversational Interface and devices.
2. **A technology of Conversation:** Introduction, Conversation as Action, The structure of Conversation, The language of Conversation.
3. **Developing a Speech-Based Conversational Interface:** Implementing Text to Speech: Text Analysis, Wave Synthesis, Implementing Speech Recognition: Language Model, Acoustic Model, Decoding. Speech Synthesis Markup Language.
4. **Advanced voice user interface design**

Books:

1. Cathy Pearl, "Designing Voice User Interfaces: Principles of Conversational Experiences"
2. Michael McTear, ZoraidaCallejas, David Griol, " The Conversational Interface: Talking to Smart Devices"
3. Martin Mitrevski, "Developing Conversational Interfaces for iOS: Add Responsive Voice Control"
4. SriniJanarthanam, " Hands-On Chatbots and Conversational UI Development: Build chatbots"

Savitribai Phule Pune University
Bachelor of Computer Engineering (2015 Course)
(Total 190 Credit)

First Year		Second Year		Third Year		Forth Year	
Credit =50		**Credit =50**		**Credit =46**		**Credit =44**	
Semester I							
Course Code	**Course**	**Course Code**	**Course**	**Course Code**	**Course**	**Course Code**	**Course**
107001	Engineering Mathematics I	210241	Discrete Mathematics	310241	Theory of Computation	410241	High Performance Computing
107002 / 107009	Engineering Physics / Engineering Chemistry	210242	Digital Electronics and Logic Design	310242	Database Management Systems (DBMS)	410242	Artificial Intelligence and Robotics
102006	Engineering Graphics I	210243	Data Structures and Algorithms	310243	Software Engineering & Project Management	410243	Data Analytics
103004 / 104012	Basic Electrical Engineering /Basic Electronics Engineering	210244	Computer Organization and Architecture	310244	Information Systems & Engineering Economics	410244	Elective I • Digital Signal Processing • Software Architecture and Design • Pervasive and Ubiquitous Computing • Data Mining and Warehousing
101005	Basic Civil and Environmental Engineering	210245	Object Oriented Programming	310245	Computer Networks (CN)	410245	Elective II • Distributed Systems • Software Testing and Quality Assurance • Operations Research • Mobile Communication
110003	Fundamentals of Programming Languages I	210246	Digital Electronics Lab	310246	Skills Development Lab	410246	Laboratory Practice I
111007	Workshop Practice	210247	Data Structures Lab	310247	DBMS Lab	410247	Laboratory Practice II
		210248	Object Oriented Programming Lab	310248	CN Lab	410248	Project Work Stage I
		210249	Soft Skills	310249	Audit Course 3	410249	Audit Course 3
		210250	Audit Course 1				

Course Code	**Course**	**Course Code**	**Course**	**Course Code**	**Course**	**Course Code**	**Course**
107008	Engineering Mathematics II	207003	Engineering Mathematics III	310250	Design & Analysis of Algorithms	410250	Machine Learning
107009 / 107002	Engineering Chemistry / Engineering Physics	210251	Computer Graphics	310251	Systems Programming & Operating System (SP & OS)	410251	Information and Cyber Security
102013	Basic Mechanical Engineering	210252	Advanced Data Structures	310252	Embedded Systems & Internet of Things (ES & IoT)	410252	Elective III Advanced Digital Signal Processing Compilers Embedded and Real Time Operating Systems Soft Computing and Optimization Algorithms
101011	Engineering Mechanics	210253	Microprocessor	310253	Software Modeling and Design	410253	Elective IV Software Defined Networks Human Computer Interface Cloud Computing Open Elective
104012 / 103004	Basic Electronics Engineering / Basic Electrical Engineering	210254	Principles of Programming Languages	310254	Web Technology	410254	Laboratory Practice III
110010	Fundamentals of Programming Languages II	210255	Computer Graphics Lab	310255	Seminar & Technical Communication	410255	Laboratory Practice IV
102014	Engineering Graphics II	210256	Advanced Data Structures Lab	310256	Web Technology Lab	410256	Project Work Stage II
		210257	Microprocessor Lab	310257	SP & OS Lab	410257	Audit Course 3
		210258	Audit Course 2	310258	ES & IoT Lab		
				310259	Audit Course 4		