

**Faculty of Engineering
Savitribai Phule Pune University, Pune**



Syllabus

for

**Third Year
Bachelor of Computer Engineering
(2015 Course)**

(with effect from 2017-18)

Prologue

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

While revising syllabus, honest and sincere efforts are put to tune Computer Engineering program syllabus in tandem with the objectives of Higher Education of India, AICTE, UGC and affiliated University (SPPU) by keeping an eye on the technological advancements and industrial requirements globally.

Syllabus revision is materialized with sincere efforts, active participation, expert opinions and suggestions from domain professionals. Sincere efforts have been put by members of BOS, teachers, alumni, industry experts in framing the draft with guidelines and recommendations.

Case Studies are included in almost all courses. Course Instructor is recommended to discuss appropriate related recent technology/upgrade/Case Studies to encourage students to study from course to the scenario and think through the largest issues/ recent trends/ utility/ developing real world/ professional skills.

I am sincerely indebted to all the minds and hands who work adroitly to materialize these tasks. I really appreciate your contribution and suggestions in finalizing the contents.

Thanks

Dr. Varsha H. Patil

Coordinator, Board of Studies (Computer Engineering), SPPU, Pune

Tuesday, March 28, 2017

[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 6-62), [all four year courses](#)(page 63), [Course-Credit share](#)(page 64)]

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 University of Pune
Third Year Computer Engineering (2015 Course)
(with effect from 2017-18)

Semester I

Course Code	Course	Teaching Scheme Hours / Week			Examination Scheme and Marks						Credit		
		Theory	Tutorial	Practical	In-Sem	End-Sem	TW	PR	OR	Total	TH/ TUT	PR	
310241	Theory of Computation	03	--	--	30	70	--	--	--	100	03	--	
310242	Database Management Systems (DBMS)	03	--	--	30	70	--	--	--	100	03	--	
310243	Software Engineering & Project Management	03	--	--	30	70	--	--	--	100	03	--	
310244	Information Systems & Engineering Economics	03	--	--	30	70	--	--	--	100	03	--	
310245	Computer Networks (CN)	04	--	--	30	70	--	--	--	100	04	--	
310246	Skills Development Lab	--	02	04	--	--	50	--	50	100	02	02	
310247	DBMS Lab	--	--	04	--	--	25	50	--	75	--	02	
310248	CN Lab	--	--	02	--	--	25	50	--	75	--	01	
Total Credit											18	05	
Total		16	02	10	150	350	100	100	50	750	23		
310249	Audit Course 3											Grade	

310249-Audit Course 3 (AC3) Options:

AC3-I: Cyber Security

AC3-II: Professional Ethics and Etiquettes

AC3-III: Emotional Intelligence

AC3-IV: MOOC- Learn New Skills

AC3-V: Foreign Language (Japanese- Module 3)

Abbreviations:

TW: Term Work **TH:** Theory **OR:** Oral **TUT:** Tutorial **PR:** Practical **Sem:** Semester

Savitribai Phule University of Pune Third Year Computer Engineering (2015 Course) (with effect from 2017-18)													
<u>Semester II</u>													
Course Code	Course	Teaching Scheme Hours / Week			Examination Scheme and Marks						Credit		
		Theory	Tutorial	Practical	In-Sem	End-Sem	TW	PR	OR	Total	TH/ TUT	PR	
310250	<u>Design & Analysis of Algorithms</u>	04	--	--	30	70	--	--	--	100	04		
310251	<u>Systems Programming & Operating System (SP & OS)</u>	04	--	--	30	70	--	--	--	100	04	--	
310252	<u>Embedded Systems & Internet of Things (ES & IoT)</u>	04	--	--	30	70	--	--	--	100	04	--	
310253	<u>Software Modeling and Design</u>	03	--	--	30	70	--	--	--	100	03	--	
310254	<u>Web Technology</u>	03	--	--	30	70	--	--	--	100	03	--	
310255	<u>Seminar & Technical Communication</u>	--	01	--	--	--	50	--	--	50	01	--	
310256	<u>Web Technology Lab</u>	--	--	02	--	--	25	50	--	75	--	01	
310257	<u>SP & OS Lab</u>	--	--	04	--	--	25	50	--	75	--	02	
310258	<u>ES & IoT Lab</u>	--	--	02	--	--	50	--	--	50	--	01	
Total Credit											19	04	
Total		18	01	08	150	350	150	100	--	750	23		
310259	<u>Audit Course 4</u>											Grade	

310259-Audit Course 4(AC4) Options:**AC4-I:** Digital and Social Media Marketing**AC4-II:** Green Computing**AC4-III:** Sustainable Energy Systems**AC4-IV:** Leadership and Personality Development**AC4-V:** Foreign Language (Japanese- Module 4)**Abbreviations:****TW:** Term Work **TH:** Theory **OR:** Oral **TUT:** Tutorial **PR:** Practical **Sem:** Semester

SEMESTER I

Savitribai Phule Pune University Third Year of Computer Engineering (2015 Course) 310241: Theory of Computation		
Teaching Scheme: TH: 03 Hours/Week	Credit 03	Examination Scheme: In-Sem (Paper): 30 Marks End-Sem (Paper): 70 Marks
Prerequisite Courses: Discrete Mathematics (210241), Principles of Programming Languages (210254)		
Course Objectives: <ul style="list-style-type: none"> • To Study abstract computing models • To learn Grammar and Turing Machine • To learn about the theory of computability and complexity. 		
Course Outcomes: On completion of the course, student will be able to– <ul style="list-style-type: none"> • design deterministic Turing machine for all inputs and all outputs • subdivide problem space based on input subdivision using constraints • apply linguistic theory 		
Course Contents		
Unit I	Formal Language Theory and Finite Automata	08 Hours
Introduction to Formal language, introduction to language translation logic, Essentials of translation, Alphabets and languages, Finite representation of language, Finite Automata (FA): An Informal Picture of FA, Finite State Machine (FSM), Language accepted by FA, Definition of Regular Language, Deterministic and Nondeterministic FA(DFA and NFA), epsilon- NFA, FA with output: Moore and Mealy machines -Definition, models, inter-conversion. Case Study: FSM for vending machine, spell checker		
Unit II	Regular Expressions (RE)	07 Hours
Introduction, Operators of RE, Building RE, Precedence of operators, Algebraic laws for RE, Conversions: NFA to DFA, RE to DFA Conversions: RE to DFA, DFA to RE Conversions: State/loop elimination, Arden's theorem Properties of Regular Languages: Pumping Lemma for Regular languages, Closure and Decision properties. Case Study: RE in text search and replace		
Unit III	Context Free Grammars (CFG) and Languages	08 Hours
Introduction, Regular Grammar, Context Free Grammar - Definition, Derivation, Language of grammar, sentential form, parse tree, inference, derivation, parse trees, ambiguity in grammar and Language- ambiguous Grammar, Simplification of CFG: Eliminating unit productions, useless production, useless symbols, and ϵ -productions, Normal Forms - Chomsky normal form, Greibach normal form, Closure properties of CFL, Decision properties of CFL, Chomsky Hierarchy, Application of CFG: Parser, Markup languages, XML and Document Type Definitions. Case Study- CFG for Palindromes, Parenthesis Match,		
Unit IV	Turing Machines (TM)	08 Hours

Turing Machine Model, Representation of Turing Machines, Language Acceptability by Turing Machines, Design of TM, Description of TM, Techniques for TM Construction, Variants of Turing Machines, The Model of Linear Bounded Automata , TM & Type 0 grammars, TM's Halting Problem.

Unit V**Pushdown Automata(PDA)****07 Hours**

Basic Definitions, Equivalence of Acceptance by Finite State & Empty stack, PDA & Context Free Language, Equivalence of PDA and CFG, Parsing & PDA: Top-Down Parsing, Top-down Parsing Using Deterministic PDA, Bottom-up Parsing, Closure properties and Deterministic PDA.

Unit VI**Undecidability & Intractable Problems****07 Hours**

A Language that is not recursively enumerable, An un-decidable problem that is RE, Post Correspondence Problem, The Classes P and NP : Problems Solvable in Polynomial Time, An Example: Kruskal's Algorithm, Nondeterministic Polynomial Time, An NP Example: The Traveling Salesman Problem, Polynomial-Time Reductions NP Complete Problems, An NP-Complete Problem: The Satisfiability Problem, Tractable and Intractable, Representing Satisfiability, Instances, NP Completeness of the SAT Problem, A Restricted Satisfiability Problem: Normal Forms for Boolean Expressions, Converting Expressions to CNF, The Problem of Independent Sets, The Node-Cover Problem.

Books:**Text:**

1. John E. Hopcroft, Rajeev Motwani, Jeffrey D.Ullman, "Introduction to Automata Theory Languages and Computation", Addison-Wesley, ISBN 0-201-44124-1.
2. H.L. Lewis, Christos H. Papadimitriou, "Elements of the Theory of Computation", Prentice Hall, ISBN-10: 0132624788; ISBN-13: 978-0132624787

References:

1. John Martin, "Introduction to Languages and The Theory of Computation", 2nd Edition, Mc Graw Hill Education, ISBN-13: 978-1-25-900558-9, ISBN-10: 1-25-900558-5
2. Sanjeev Arora and Boaz Barak, "Computational Complexity: A Modern Approach", Cambridge University Press, ISBN:0521424267 9780521424264
3. Daniel Cohen, "Introduction to Computer Theory", Wiley & Sons, ISBN 9788126513345
4. J. Carroll & D Long, "Theory of Finite Automata", Prentice Hall, ISBN 0-13-913708-4
5. Kavi Mahesh, "Theory of Computation : A Problem-Solving Approach", Wiley India, ISBN10 8126533110
6. Michael Sipser, "Introduction to the Theory of Computation", Cengage Learning, ISBN-13: 9781133187813
7. Vivek Kulkarni "Theory of Computation", Oxford University Press, ISBN 0-19-808458

Savitribai Phule Pune University Third Year of Computer Engineering (2015 Course) 310242 : Database Management Systems		
Teaching Scheme: TH: 03 Hours/Week	Credit 03	Examination Scheme: In-Sem (Paper): 30 Marks End-Sem (paper): 70 Marks
Prerequisites Courses : Discrete Mathematics (210241), Data Structures (210243 & 210252)		
Companion Course: Database Management System Lab (310247)		
Course Objectives :		
<ul style="list-style-type: none"> • To understand the fundamental concepts of database management. These concepts include aspects of database design, database languages, and database-system implementation • To provide a strong formal foundation in database concepts, technology and practice • To give systematic database design approaches covering conceptual design, logical design and an overview of physical design • Be familiar with the basic issues of transaction processing and concurrency control • To learn and understand various Database Architectures and Applications • To learn a powerful, flexible and scalable general purpose database to handle big data 		
Course Outcomes :		
On completion of the course, student will be able to–		
<ul style="list-style-type: none"> • Design E-R Model for given requirements and convert the same into database tables. • Use database techniques such as SQL & PL/SQL. • Use modern database techniques such as NOSQL. • Explain transaction Management in relational database System. • Describe different database architecture and analyses the use of appropriate architecture in real time environment. • Use advanced database Programming concepts 		
Course Contents		
Unit I	Introduction	07 Hours
Introduction to Database Management Systems, Purpose of Database Systems, Database-System Applications, View of Data, Database Languages, Database System Structure, Data Models, Database Design and ER Model: Entity, Attributes, Relationships, Constraints, Keys, Design Process, Entity Relationship Model, ER Diagram, Design Issues, Extended E-R Features, converting E-R & EER diagram into tables.		
Unit II	SQL AND PL/SQL	07 Hours
SQL: Characteristics and advantages, SQL Data Types and Literals, DDL, DML, DCL, TCL, SQL Operators, Tables: Creating, Modifying, Deleting, Views: Creating, Dropping, Updating using Views, Indexes, SQL DML Queries: SELECT Query and clauses, Set Operations, Predicates and Joins, Set membership, Tuple Variables, Set comparison, Ordering of Tuples, Aggregate Functions, Nested Queries, Database Modification using SQL Insert, Update and Delete Queries. PL/SQL: concept of Stored Procedures & Functions, Cursors, Triggers, Assertions, roles and privileges , Embedded SQL, Dynamic SQL.		
Unit III	Relational Database Design	08 Hours

Relational Model: Basic concepts, Attributes and Domains, CODD's Rules, Relational Integrity: Domain, Referential Integrities, Enterprise Constraints, Database Design: Features of Good Relational Designs, Normalization, Atomic Domains and First Normal Form, Decomposition using Functional Dependencies, Algorithms for Decomposition, 2NF, 3NF, BCNF, Modeling Temporal Data.

Unit IV	Database Transactions and Query Processing	08 Hours
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Basic concept of a Transaction, Transaction Management, Properties of Transactions, Concept of Schedule, Serial Schedule, Serializability: Conflict and View, Cascaded Aborts, Recoverable and Non-recoverable Schedules, Concurrency Control: Need, Locking Methods, Deadlocks, Time-stamping Methods, Recovery methods : Shadow-Paging and Log-Based Recovery, Checkpoints, Query Processing, Query Optimization, Performance Tuning.

Unit V	Parallel and Distributed Databases	07 Hours
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Introduction to Database Architectures: Multi-user DBMS Architectures, Case study- Oracle Architecture. **Parallel Databases:** Speedup and Scale up, Architectures of Parallel Databases. **Distributed Databases:** Architecture of Distributed Databases, Distributed Database Design, Distributed Data Storage, Distributed Transaction: Basics, Failure modes, Commit Protocols, Concurrency Control in Distributed Database.

Unit VI	NoSQL Database	08 Hours
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Introduction to NoSQL Database, Types and examples of NoSQL Database- Key value store, document store, graph, Performance, Structured verses unstructured data, Distributed Database Model, CAP theorem and BASE Properties, Comparative study of SQL and NoSQL, NoSQL Data Models, Case Study-unstructured data from social media. Introduction to Big Data, HADOOP: HDFS, MapReduce.

Books:

Text:

1. Silberschatz A., Korth H., Sudarshan S., "Database System Concepts", McGraw Hill Publishers, ISBN 0-07-120413-X, 6th edition
2. Connally T, Begg C., "Database Systems", Pearson Education, ISBN 81-7808-861-4
3. Pramod J. Sadalage and Martin Fowler, "NoSQL Distilled", Addison Wesley, ISBN-10: 0321826620, ISBN-13: 978-0321826626

References:

1. C J Date, "An Introduction to Database Systems", Addison-Wesley, ISBN: 0201144719
2. S.K.Singh, "Database Systems : Concepts, Design and Application", Pearson, Education, ISBN 978-81-317-6092-5
3. Kristina Chodorow, Michael Dirolf, "MangoDB: The Definitive Guide" ,O'Reilly Publications, ISBN: 978-1-449-34468-9.
4. Adam Fowler, "NoSQL For Dummies", John Wiley & Sons, ISBN-1118905628
5. Kevin Roebuck, "Storing and Managing Big Data - NoSQL, HADOOP and More", Emereoty Limited, ISBN: 1743045743, 9781743045749
6. Joy A. Kreibich, "Using SQLite", O'REILLY, ISBN: 13:978-93-5110-934-1
7. Garrett Grolemond, "Hands-on Programming with R", O'REILLY, ISBN : 13:978-93-5110-728-6

Savitribai Phule Pune University Third Year of Computer Engineering (2015 Course) 310243: Software Engineering and Project Management		
Teaching Scheme: TH: 03 Hours/Week	Credit 03	Examination Scheme: In-Sem (Paper): 30 Marks End-Sem (Paper): 70 Marks
Prerequisite Courses: Fundamentals of Programming Languages (110003, 110011)		
Course Objectives: <ul style="list-style-type: none"> • To learn and understand the principles of Software Engineering • To be acquainted with methods of capturing, specifying, visualizing and analyzing software requirements. • To apply Design and Testing principles to S/W project development. • To understand project management through life cycle of the project. • To understand software quality attributes. 		
Course Outcomes: On completion of the course, student will be able to– <ul style="list-style-type: none"> • Decide on a process model for a developing a software project • Classify software applications and Identify unique features of various domains • Design test cases of a software system. • Understand basics of IT Project management. • Plan, schedule and execute a project considering the risk management. • Apply quality attributes in software development life cycle. 		
Course Contents		
Unit I	Introduction to Software Engineering, Software Process Models	07 Hours
Software Engineering Fundamentals: Nature of Software, Software Engineering Principles, The Software Process, Software Myths. Process Models : A Generic Process Model, Prescriptive Process Models: The Waterfall, Incremental Process(RAD), Evolutionary Process, Unified Process, Concurrent. Advanced Process Models & Tools: Agile software development: Agile methods, Plan-driven and agile development, Extreme programming Practices, Testing in XP, Pair programming. Introduction to agile tools: JIRA, Kanban, Case Studies: An information system (mental health-care system), wilderness weather system		
Unit II	Software Requirements Engineering& Analysis	08 Hours
Requirements Engineering: User and system requirements, Functional and non-functional requirements, Types & Metrics, A spiral view of the requirements engineering process. Software Requirements Specification (SRS): The software requirements Specification document, The structure of SRS, Ways of writing a SRS, structured & tabular SRS for an insulin pump case study, Requirements elicitation & Analysis: Process, Requirements validation, Requirements management. Case Studies: The information system. Case study - Mental health care patient management system (MHC-PMS).		
Unit III	Design Engineering	08 Hours
Design Process & quality, Design Concepts, The design Model, Pattern-based Software Design. Architectural Design : Design Decisions, Views, Patterns, Application Architectures, Modeling Component level Design: component, Designing class based components, conducting component-level design, User Interface Design: The golden rules, Interface Design steps & Analysis, Design Evaluation, Case Study: Web App Interface Design		

Unit IV	Project Management: Process, Metrics, Estimations & Risks	08 Hours
<p>Project Management Concepts: The Management Spectrum, People, Product, Process, Project, The W5HH Principle, Metrics in the Process and Project Domains, Software Measurement : size & function oriented metrics(FP & LOC), Metrics for Project and Software Quality, Project Estimation :Observations on Estimation, Project Planning Process, Software Scope and feasibility, Resources: Human Resources, Reusable software, Environmental Resources. Software Project Estimation, Decomposition Techniques, Empirical Estimation Models: Structure, COCOMO II, Estimation of Object-oriented Projects, Specialized Estimation Case Study: Software Tools for Estimation, Project Scheduling: Basic Concepts, Defining a Task Set for the Software Project, Defining Task Network, Scheduling with time-line charts, Schedule tracking Tools:- Microsoft Project, Daily Activity Reporting & Tracking (DART)</p>		
Unit V	Project Management: Risk Management, Configuration Management, Maintenance & Reengineering	07 Hours
<p>Project Risk Management : Risk Analysis & Management: Reactive versus Proactive Risk Strategies, Software Risks, Risk Identification, Risk Projection, Risk Refinement, Risk Mitigation, Risks Monitoring and Management, The RMMM plan for case study project</p> <p>Software Configuration Management : The SCM repository, SCM process, Configuration management for WebApps, Case study: CVS and Subversion Tools, Visual Source Safe from Microsoft & Clear Case. Maintenance & Reengineering: Software Maintenance, Software Supportability, Reengineering, Business Process Reengineering, Software Reengineering, Reverse Engineering, Restructuring, Forward Engineering</p>		
Unit VI	Software Testing	07 Hours
<p>Introduction to Software Testing, Principles of Testing, Testing Life Cycle, Phases of Testing, Types of Testing, Verification & Validation, Defect Management, Defect Life Cycle, Bug Reporting, GUI Testing, Test Management and Automation.</p>		
<p>Books:</p>		
<p>Text:</p> <ol style="list-style-type: none"> 1. Roger Pressman, “Software Engineering: A Practitioner’s Approach”, McGraw Hill, ISBN 0-07-337597-7 2. Ian Sommerville, “ Software Engineering”, Addison and Wesley, ISBN 0-13-703515-2 		
<p>References:</p> <ol style="list-style-type: none"> 1. Carlo Ghezzi, “Fundamentals of Software Engineering”, Prentice Hall India, ISBN-10: 0133056996 2. Rajib Mall, “Fundamentals of Software Engineering”, Prentice Hall India, ISBN-13: 978-8120348981 3. Pankaj Jalote, “An Integrated Approach to Software Engineering”, Springer, ISBN 13: 9788173192715. 4. S K Chang, “Handbook of Software Engineering and Knowledge Engineering”, World Scientific, Vol I, II, ISBN: 978-981-02-4973-1 5. Tom Halt, “Handbook of Software Engineering”, Clanye International, ISBN-10: 1632402939 		

Savitribai Phule Pune University Third Year of Computer Engineering (2015 Course) 310244: Information Systems and Engineering Economics		
Teaching Scheme: TH: 03 Hours/Week	Credit 03	Examination Scheme: In-Sem (Paper): 30 Marks End-Sem (Paper): 70 Marks
Course Objectives: <ul style="list-style-type: none"> • To prepare the students to various forms of the Information Systems and its application in organizations. • To expose the students to the managerial issues relating to information systems and help them identify and evaluate various options in Information Systems. • To Prepare engineering students to analyze cost / revenue data and should be able to do economic analyses in the decision making process to justify or reject alternatives / projects on an economic basis for an organization. 		
Course Outcomes: On completion of the course, student will be able to– <ul style="list-style-type: none"> • Understand the need, usage and importance of an Information System to an organization. • Understand the activities that are undertaken while managing, designing, planning, implementation, and deployment of computerized information system in an organization. • Further the student would be aware of various Information System solutions like ERP, CRM, Data warehouses and the issues in successful implementation of these technology solutions in any organizations • Outline the past history, present position and expected performance of a company engaged in engineering practice or in the computer industry. • Perform and evaluate present worth, future worth and annual worth analyses on one of more economic alternatives. • Be able to carry out and evaluate benefit/cost, life cycle and breakeven analyses on one or more economic alternatives. 		
Course Contents		
Unit I	Basic of Management Theory & Practices	07 Hours
Role of Information Systems in Organizations, The Information System Manager and his challenges, Concepts of Information Systems, Information Systems and Management Strategy Case Studies - Information Systems in the Indian Railways, Information Systems in an e-Commerce Organization.		
Unit II	Management Information System (MIS)	08 Hours
Managing Information Systems, Ethical and Social Issues, Information Technology Infrastructure and Choices, Information Systems Security and Control, Case Studies -Information Technology Infrastructure in a Bank, Information Technology Infrastructure in a manufacturing / process industry.		

Unit III	Leveraging Information Systems	07 Hours
Information Systems Development and Project Management, Managing Data Resources, Business Process Integration and Enterprise Systems, ICT for Development and E-Governance, Case Studies - in-house or cloud based ERP implementation, UIDAI Unique Identification Authority of India.		
Unit IV	Money and Economic Value	08 Hours
Engineering Economic Decisions, Time Value of Money, Understanding Money Management, Case Studies- Economic decisions done in Multi-national companies.		
Unit V	Economics and Management	07 Hours
Equivalence Calculations under Inflation, Present-Worth Analysis, Annual-Equivalence Analysis. Case Studies -comparative analysis of software enterprises from relevant domains.		
Unit VI	Understanding Cash Flow and Taxes	08 Hours
Accounting for Depreciation and Income Taxes, Project Cash-Flow Analysis, Understanding Financial Statements, Case Studies - cash flow analysis done in start-up companies.		
Books:		
Text:		
<ol style="list-style-type: none"> 1. Rahul De, "MIS: Management Information Systems in Business, Government and Society", Wiley India, ISBN: 13: 978-81-265-2019-0. 2. Chan S. Park , "Fundamentals of Engineering Economics", 3rd Edition, Pearson Education, ISBN 13: 978-02-737-7291-0 		
References:		
<ol style="list-style-type: none"> 1. Turban and Wali, "Information Technology on Management", Willey India, ISBN:9788126558711 2. William G. Sullivan, Elin M. Wicks, C. Patrick Koelling, Engineering Economy, Pearson Education, ISBN13: 978-01-334-3927-4 		

Savitribai Phule Pune University Third Year of Computer Engineering (2015 Course) 310245: Computer Networks		
Teaching Scheme: TH: 04 Hours/Week	Credit 04	Examination Scheme: In-Sem (Paper): 30 Marks End-Sem (Paper): 70 Marks
Prerequisite Courses: Computer Organization and Architecture (210244)		
Companion Course: Computer Network Lab (310248)		
Course Objectives:		
<ul style="list-style-type: none"> • To understand the fundamental concepts of networking standards, protocols and technologies. • To learn different techniques for framing, error control, flow control and routing. • To learn role of protocols at various layers in the protocol stacks. • To learn network programming. • To develop an understanding of modern network architectures from a design and performance perspective 		
Course Outcomes:		
On completion of the course, student will be able to–		
<ul style="list-style-type: none"> • Analyze the requirements for a given organizational structure to select the most appropriate networking architecture, topologies, transmission mediums, and technologies • Demonstrate design issues, flow control and error control • Analyze data flow between TCP/IP model using Application, Transport and Network Layer Protocols. • Illustrate applications of Computer Network capabilities, selection and usage for various sectors of user community. • Illustrate Client-Server architectures and prototypes by the means of correct standards and technology. • Demonstrate different routing and switching algorithms 		
Course Contents		
Unit I	Physical Layer	09 Hours
Introduction of LAN; MAN; WAN; PAN, Ad-hoc Network, Network Architectures: Client-Server; Peer To Peer; Distributed and SDN, OSI Model, TCP/IP Model, Topologies: Star and Hierarchical; Design issues for Layers, Transmission Mediums: CAT5, 5e, 6, OFC and Radio Spectrum, Network Devices: Bridge, Switch, Router, Brouter and Access Point, Manchester and Differential Manchester Encodings; IEEE802.11: Frequency Hopping (FHSS) and Direct Sequence (DSSS)		
Unit II	Logical Link Control	09 Hours
Design Issues: Services to Network Layer, Framing, Error Control and Flow Control. Error Control: Parity Bits, Hamming Codes (11/12-bits) and CRC. Flow Control Protocols: Unrestricted Simplex, Stop and Wait, Sliding Window Protocol, WAN Connectivity : PPP and HDLC		
Unit III	Medium Access Control	09 Hours

Channel allocation: Static and Dynamic, Multiple Access Protocols: Pure and Slotted ALOHA, CSMA, WDMA, IEEE 802.3 Standards and Frame Formats, CSMA/CD, Binary Exponential Back-off algorithm, Fast Ethernet, Gigabit Ethernet, IEEE 802.11a/b/g/n and IEEE 802.15 and IEEE 802.16 Standards, Frame formats, CSMA/CA.

Unit IV	Network Layer	09 Hours
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Switching techniques, IP Protocol, IPv4 and IPv6 addressing schemes, Subnetting, NAT, CIDR, ICMP, Routing Protocols: Distance Vector, Link State, Path Vector, Routing in Internet: RIP, OSPF, BGP, Congestion control and QoS, MPLS, Mobile IP, Routing in MANET : AODV, DSR

Unit V	Transport Layer	09 Hours
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Services, Berkley Sockets, Addressing, Connection establishment, Connection release, Flow control and buffering, Multiplexing, TCP, TCP Timer management, TCP Congestion Control, Real Time Transport protocol(RTP), Stream Control Transmission Protocol (SCTP), Quality of Service (QoS), Differentiated services, TCP and UDP for Wireless.

Unit VI	Application Layer	09 Hours
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Domain Name System (DNS), Hyper Text Transfer Protocol (HTTP), Email: SMTP, MIME, POP3, Webmail, FTP, TELNET, Dynamic Host Control Protocol (DHCP), Simple Network Management Protocol (SNMP).

Books:

Text:

1. Andrew S. Tenenbaum, "Computer Networks", PHI, ISBN 81-203-2175-8.
2. Fourauzan B., "Data Communications and Networking", 5th Edition, Tata McGraw- Hill, Publications, ISBN: 0 – 07 – 058408 – 7

References:

1. Kurose, Ross "Computer Networking a Top Down Approach Featuring the Internet", Pearson, ISBN-10: 0132856204
2. Matthew S. G, "802.11 Wireless Networks", O'Reilly publications, ISBN: 81-7656-992-5
3. C. Siva Ram Murthy and B. S. Manoj, "Ad Hoc Wireless Networks: Architectures and Protocols" Prentice Hall, ISBN-10: 8131706885; ISBN-13: 978-8131706886
4. Holger Karl and Andreas Willing, "Protocols and Architectures for Wireless Sensor Networks", Wiley India , ISBN: 9788126533695
5. Eldad Perahia, Robert Stacey, "Next Generation Wireless LANs", Cambridge, ISBN-10: 1107016762; ISBN-13: 978-1107016767
6. Efraim Turban, Linda Volonino, Gregory R. Wood "Computer Networking a Top Down Approach Featuring the Internet", 10th Edition, Wiley; ISBN13: 978-1-118-96126-1

Savitribai Phule Pune University
Third Year of Computer Engineering (2015 Course)
310246: Skill Development Lab

Teaching Scheme:	Credit (04)		Examination Scheme:
TUT: 02 Hour/Week	Tutorial	PR	TW: 50 Marks
PR: 04 Hours/Week	02	02	OR: 50 Marks

Prerequisite Courses: Fundamentals of Programming Languages (110003 and 110011), Principles of Programming Languages (210254), Data Structures and Algorithms (210243), Object Oriented Programming(210245)

Course Objectives:

- To adapt the usage of modern tools and recent software.
- To evaluate problems and analyze data using current technologies
- To learn the process of creation of data-driven web applications using current technologies
- To understand how to incorporate best practices for building enterprise applications
- To learn how to employ Integrated Development Environment(IDE) for implementing and testing of software solution
- To construct software solutions by evaluating alternate architectural patterns.

Course Outcomes:

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

- Evaluate problems and analyze data using current technologies in a wide variety of business and organizational contexts.
- Create data-driven web applications
- Incorporate best practices for building applications
- Employ Integrated Development Environment(IDE) for implementing and testing of software solution
- Construct software solutions by evaluating alternate architectural patterns.

Guidelines for Instructor's Manual

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

Guidelines for Student Journal

The laboratory assignments are to be submitted by student in the form of journal. Journal consists of prologue, Certificate, table of contents, and **handwritten write-up** of each assignment (Title, Objectives, Problem Statement, Outcomes, software & Hardware requirements, Date of Completion, Assessment grade/marks and assessor's sign, Theory-Concept in brief, features of tool/framework/language used, Design, test cases, conclusion. **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 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 done based on overall performance and lab assignments performance of student. Each lab assignment assessment will assign grade/marks based on parameters with appropriate weightage. Suggested parameters for overall assessment as well as each lab assignment assessment include- timely completion, performance, innovation, efficient codes, punctuality and neatness.

Guidelines for Oral Examination

It is recommended to conduct examination based on Mini-Project demonstration and related skill learned. Team of 3 to 4 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. So 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 Laboratory Conduction

The instructor is expected to frame the assignments by understanding the prerequisites, technological aspects, utility and recent trends related to the topic. The assignment framing policy need to address the average students and inclusive of an element to attract and promote the intelligent students. The instructor may set multiple sets of assignments and distribute among batches of students. It is appreciated if the assignments are based on real world problems/applications. Encourage students for appropriate use of Hungarian notation, proper indentation and comments. Use of open source software is to be encouraged.

In addition to these, instructor may assign one real life application in the form of a mini-project based on the concepts learned. Instructor may also set one assignment or mini-project that is suitable to respective branch beyond the scope of syllabus.

For this laboratory total five Skill Development Modules plus one Aptitude Development Module are provided as below:

SD Module-I: Advanced JAVA and Mobile Application Development

SD Module-II: PYTHON and DATA Science with R

SD Module-III: Advanced JAVA and GROOVY on GRAILS

SD Module-IV: SCHEME and SCALA and GROOVY on GRAILS

SD Module-V: Advanced JAVA and Data Science with R

SD Module VI: Aptitude Development (To be EXCLUDED for Oral Exam)

Instructions:

Each college has to select at least one module out of five modules provided. College can select more than one module too! Set of suggested assignments is provided. Each student must perform 7 to 8 assignments and at least one mini-project provided in each module excluding Module VI. Instructor should frame set of mini projects or guide students to frame the problem statement of mini-project by sticking to technologies in respected module.

Term Work will be based on assignments be carried out by students and **Oral Examination will be based on Mini-Project demonstration and related skill learned ONLY.**

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

Programming tools recommended: - Open Source C,C++, JAVA, PYTHON, G++/GCC, R, Grails, Groovy, Android Studio for Linux.

Course Contents

SD Module-I	Advanced JAVA and Mobile Application Development
	Theory Content for Lab
ADVANCED JAVA	
<p>Data Structures in Java: Enumeration, BitSet, Vector, Stack, Dictionary, Hash table, Properties. Generics and Collection Framework: Generic Methods and Generic Classes. Interfaces (Set, List, Queue, and Dequeue) and classes (ArrayList, Vector, LinkedList, PriorityQueue, HashSet, LinkedHashSet, and TreeSet). Serialization and Networking: Serializing an Object and Deserializing an Object, Socket Programming. Database Connectivity and Multithreading: SQL, JDBC, Thread life cycle, Thread methods, Thread Pools, Executor Service. GUI in JAVA: AWT, Applet, Swing.</p>	
MOBILE APPLICATION DEVELOPMENT	
<p>Introduction to Android: Android Platform Architecture, Basic components of android, Features of ART and Dalvik Virtual Machine, Activity Life Cycle, Intents and Intent Filters, Resources, System Permissions, Android Application Structure, Device screen size compatibility, Android Emulator User Interface components: Layouts, RecyclerView, ListView, GridView and WebView, Input Controls: Buttons, Checkboxes, Radio Buttons, Toggle Buttons, Spinners, Input Events, Menus, Toast, Dialogs, Styles and Themes, Multimedia, Animation and Graphics: Playing Audio, Playing Video, Rotate Animation, FadeIn/FadeOut Animation, Zoom Animation, Scale Animation, 2D and 3D Graphics. Data Storage: Shared Preferences, Internal Storage, External Storage, SQLite Databases, Content provider. and Remote Databases, Advanced Components of Android: Web App, JSON Parsing, Google Map, GPS, Sensors, Bluetooth/Wi-Fi Connectivity</p>	
Books:	
Text:	
<ol style="list-style-type: none"> Herbert Schildt, "Java: The Complete Reference", TMG Publication, ISBN 9780070636774 Thomas Powell, "Java generics and collections", O'Reilly Media, ISBN: 0596527756 Neil Smyth, "Android Studio 2 Development Essentials", Payload Media, ISBN: 1532853319 John Horton, "Android Programming for Beginners", ISBN 10:1785883267 	
Reference:	
<ol style="list-style-type: none"> Sharanam Shah and Vaishali Shah, "JAVA EE 7 for Beginners", SPD, ISBN: 13:978-93-5110-349-3 Reto Meier, "Professional Android 4 Application Development", Wrox, ISBN-10: 1118102274; ISBN-13: 978-1118102275 Greg Nudelman, "Android Design Patterns :Interaction Design Solutions for Developers", ISBN-10: 1118394151; ISBN-13: 978-1118394151 Sharanam Shah, Vaishali Shah," Core Java 8 for beginners", THE TEAM, ISBN: 13:978-93-5213-080-1 	
Suggested List of Laboratory Assignments for Advanced JAVA	
1.	Design a system with the help of advance data structures in Java and enhance the system using collections and generics.
2.	Enhance the above system with the help of socket programming use client server architecture.
3.	Enhance above system by using JDBC, Multithreading, concurrency, synchronous and asynchronous callbacks, ThreadPools using ExecutorService.
4.	Transform the above system from command line system to GUI based application
Suggested List of Laboratory Assignments for Mobile Application Development	
1.	Download Install and Configure Android Studio on Linux/windows platform.
2.	Design a mobile app for media player.
3.	Design a mobile app to store data using internal or external storage.
4.	Design a mobile app using Google Map and GPS to trace the location.
Suggested Mini Project on Advanced JAVA and Mobile Application Development	

Design and develop a mobile app for novice trekkers by recording the paths from regular trekkers by using, Material Design Pattern for UI, Storage [SQLite database/File/Shared Preference/cloud], Internet connection /Wi-Fi/Bluetooth, GPS and Google Map.

SD Module-II**PYTHON and DATA Science with R****Theory Content for Lab****PYTHON**

Python Basics: Data types, Statements and Expressions, Operators and Math's, Conditionals, Loops, Strings, List, Tuples, Set Operation, Dictionary (Dict), Date and Times.

Functions, Packages and Classes: Lambda function, Regular expression, Packages, Files, Exception Handling, Classes, Objects, Method, class and instance variable, constructor, destructor, inheritance.

Numpy and Matplotlib: Array operations, Numpy Side Effects, 2D Numpy Arrays, Numpy Basic Statistics, Universal Function, Matplotlib: Introduction, Simple plots, Line API, Legend API, Figures, Subplots, Axes and Ticks.

Pandas: Look Ups, Selections and Indexing, Filling Methods, Series operation, Handling NaN values, Mapping, Data Frames, Reading Files, Plotting, Joins, Correlation, Histograms, Rolling calculation, Date Time indexing, Grouping, Aggregate Functions, pandas.IO. Data, Panel.

DATA SCIENCE WITH R

Introduction to Data Science- What is Data Science? Current landscape of perspectives, Skill sets needed, The Data Science Process life cycle, Role of Data Scientist. Data pre-processing. ETL – extract, transform, and load.

Introduction to R-What is R? Installation of R. Basic features of R. R Objects. Creating Vectors and Matrices. Getting Data in and out of R. Using different packages related to data science. Managing Data frames and Functions.

Descriptive Statistics using R - Discrete and continuous random variables, densities and distributions. Data Summarization: Measures of Central Tendency, Measures of Dispersion (quartiles, five number summary, variance, standard deviation), Measures of shape (skewness, kurtosis), Measures of association (covariance, correlation), Outliers. Using R for descriptive statistics and data visualization using ggplot2 package.

Predictive Analysis using Machine Learning Techniques using R: Machine learning - what, how, where. Supervised, unsupervised and semi-supervised learning. Training, validation, testing, generalization, over fitting. Building a Regression model using R. Features and feature engineering. Using Decision trees, Linear classifiers, Naïve Bayes, Nearest neighbor methods in R packages.

Books:**Text:**

1. Zed A. Shaw, "Learn PYTHON The Hard Way", Pearson, ISBN: 978-93-325-8210-1
2. Kenneth A Lambert and B L Juneja, "Fundamentals of PYTHON", CENGAGE Learning, ISBN:978-81-315-2903-4
3. Peng, Roger D and Elizabeth Matsui, "The Art of Data Science." A Guide for Anyone Who Works with Data. Skybrude Consulting 200 (2015): 162.
4. Evans, James R., and Carl H. Lindner, "Business analytics: the next frontier for decision sciences." Decision Line 43.2 (2012): 4-6.

Reference:

1. Allen B Downey, "Think PYTHON", O'Rielly, ISBN: 13:978-93-5023-863-9, 4th Indian Reprint 2015
2. Jiawei Han and Micheline Kamber, Morgan Kaufman, "Learning R, Richard Cotton", O'Reilly, ISBN: 13:978-93-5110-286-1, First Edition, Fourth Indian Reprint 2015

Suggested List of Laboratory Assignments on PYTHON

1. Getting Started with Python (Example Word count exercise)
2. Build the Hangman Game using Python.

3.	Write python code that loads any dataset (example Game_medal.csv), and plot the graph.
4.	Write python code that loads any dataset (example Game_medal.csv), and does some basic data cleaning. Add component on data set.
Suggested List of Laboratory Assignments on DATA Science with R	
1.	Getting Started with R installation, R objects and basic statistics.
2.	Using R for data preprocessing, exploratory analysis, visualization.
3.	Using R for correlation and regression analysis.
4.	Data analysis case study using R for readily available data set using any one machine learning algorithm
Suggested Mini Project on PYTHON and DATA Science with R	
<ol style="list-style-type: none"> 1. Implementing a simple Recommender System based on user buying pattern. 2. Twitter Sentiment Analysis in Python 3. Applying linear regression model to a real world problem. 	
SD Module-III Advanced JAVA and GROOVY on GRAILS	
Theory Content for Lab	
ADVANCED JAVA	
<p>Data Structures in Java: Enumeration, BitSet, Vector, Stack, Dictionary, Hash table, Properties. Generics and Collection Framework: Generic Methods and Generic Classes. Interfaces (Set, List, Queue, and Dequeue) and classes (ArrayList, Vector, LinkedList, PriorityQueue, HashSet, LinkedHashSet, and TreeSet). Serialization and Networking: Serializing an Object and Deserializing an Object, Socket Programming. Database Connectivity and Multithreading: SQL, JDBC, Thread life cycle, Thread methods, Thread Pools, Executor Service. GUI in JAVA: AWT, Applet, Swing.</p>	
GROOVY on GRAIL	
<p>Introduction to Grails: Object Relational Mapping (GORM), Basic CRUD, Scaffolding JSON, REST API, DataSources and Environments. Web Layer: Model, View, Controllers (MVC), Redirects and Chaining, Data Binding, Groovy Server Pages, URL Mappings, Plug-in, Grails and Hibernate.</p>	
Books:	
Text:	
<ol style="list-style-type: none"> 1. Herbert Schildt, "Java: The Complete Reference", TMG Publication, ISBN 9780070636774 2. Thomas Powell, "Java Generics and collections", O'Reilly Media, ISBN: 0596527756. 3. Christopher M. Judd, Joseph Faisal Nusairat, and James Shingler, "Beginning Groovy and Grails From Novice to Professional", Apress, ISBN-13: 978-1-4302-1045-0 	
Reference:	
<ol style="list-style-type: none"> 1. Sharanam Shah and Vaishali Shah, "JAVA EE 7 for Beginners", SPD, ISBN: 13:978-93-5110-349-3 2. Official Website http://docs.grails.org/latest/ 	
Suggested List of Laboratory Assignments for Advanced JAVA	
1.	Design a system with the help of advance data structures in Java and enhance the system using collections and generics.
2.	Enhance the above system with the help of socket programming use client server architecture.
3.	Enhance above system by using JDBC, Multithreading, concurrency, synchronous and asynchronous callbacks, Thread Pools using Executor Service.
4.	Transform the above system from command line system to GUI based application

Suggested List of Laboratory Assignments on GROOVY on GRAILS	
1.	Download Install and Configure IDE with Grails Plug-in on Windows/Linux platform.
2.	Design a simple web application using Scaffolding data source for CRUD operations
3.	Design a simple web application using MySQL for CRUD operations
Suggested Mini Project on Advanced JAVA and GROOVY on GRAILS	
Design a dynamic web application system(Ex, Employee Payroll System, Student Result System)	
SD Module-IV SCHEME and SCALA and GROOVY on GRAILS	
Theory Content for Lab	
SCHEME and SCALA	
<p>SCHEME: lambda calculus, Atoms, Lists, lambda expressions. Functions as first class objects. Control structures, Recursion and continuations, operations on objects, basic input output, Exceptions and conditions, lazy evaluation and streams.</p> <p>SCALA: Classes and Objects, Data Types, Control structures, composition and inheritance. Packages. Pattern matching. Collections API. Working with XML. Actors and concurrency. GUI programming in SCALA.</p>	
GROOVY on GRAILS	
<p>Introduction to Grails: Object Relational Mapping (GORM), Basic CRUD, Scaffolding JSON, REST API, DataSources and Environments</p> <p>Web Layer: Model ,View ,Controllers (MVC), Redirects and Chaining, Data Binding, Groovy Server Pages, URL Mappings, Plug-in, Grails and Hibernate</p>	
Books:	
Text:	
<ol style="list-style-type: none"> 1. R Kent Dybvig, “the Scheme Programming Language”, MIT Press, ISBN 978-0-262-51298-5. 2. Martin Odersky, Lex Spoon, and Bill Venner, “Programming in SCALA”, Artima. ISBN :-13: 978-0-9815316-1-8. 3. Beginning Groovy and Grails From Novice to Professional, Christopher M. Judd, Joseph Faisal Nusairat, and James Shingler, Apress, ISBN-13: 978-1-4302-1045-0 	
Reference:	
<ol style="list-style-type: none"> 1. Cay S Horstmann, “Scala for the Impatient”, Pearson, ISBN: 978-81-317-9605-4, 2. Scala Cookbook, Alvin Alexander, O’Reilly, SPD,ISBN: 978-93-5110-263-2 3. Jason Swartz, “Learning Scala”, O'REILLY, ISBN: 13:978-93-5213-256-0 4. Official Website http://www.groovy-lang.org/download.html 5. Official Website https://en.wikipedia.org/wiki/Scheme_(programming_language) 6. Official Website https://www.scala-lang.org/ 7. Official Website https://grails.org/ 	
Suggested List of Laboratory Assignments on SCHEME and SCALA	
1.	Create a recursive function in Scheme that displays the sum of n odd numbers starting from 1.
2.	Write a program to find sum and product of all the elements of a list in scheme without using built in functions.
3.	Write a SCALA Program to perform following operations on Strings: <ol style="list-style-type: none"> 1. Create a String Object. 2. Check String is palindrome or not. 3. Check length of String 4. Replace all ‘a’ in a string with ‘A’
4.	Develop a SCALA pattern matching programming which matches a given Person object and displays whether he/she is Eligible for Election or not. Use name, age and eligibility as class members.

Suggested List of Laboratory Assignments on GROOVY on GRAILS

- | | |
|----|---|
| 1. | Download Install and Configure IDE with Grails Plugins on Windows/Linux platform. |
| 2. | Design a simple web application using Scaffolding data source for CRUD operations |
| 3. | Design a simple web application using MySQL for CRUD operations |

Suggested Mini Project on SCHEME and SCALA and GROOVY on GRAILS

Design a dynamic web application system Use Front End: Groovy on Grails, Back End: Scheme and Scala (Ex, Employee Payroll System, Student Result System)

SD Module-V

Advanced JAVA and Data Science with R

Theory Content for Lab

ADVANCED JAVA

Data Structures in Java: Enumeration, BitSet, Vector, Stack, Dictionary, Hash table, Properties.

Generics and Collection Framework: Generic Methods and Generic Classes. Interfaces (Set, List, Queue, and Dequeue) and classes (ArrayList, Vector, LinkedList, PriorityQueue, HashSet, LinkedHashSet, and TreeSet). **Serialization and Networking:** Serializing an Object and Deserializing an Object, Socket Programming. **Database Connectivity and Multithreading:** SQL, JDBC, Thread life cycle, Thread methods, Thread Pools, Executor Service. **GUI in JAVA:** AWT, Applet, Swing.

DATA SCIENCE WITH R

Introduction to Data Science- What is Data Science? Current landscape of perspectives, Skill sets needed, The Data Science Process life cycle, Role of Data Scientist. Data pre-processing. ETL – extract, transform, and load.

Introduction to R-What is R? Installation of R. Basic features of R. R Objects. Creating Vectors and Matrices. Getting Data in and out of R. Using different packages related to data science. Managing Data frames and Functions.

Descriptive Statistics using R - Discrete and continuous random variables, densities and distributions .Data Summarization: Measures of Central Tendency, Measures of Dispersion (quartiles, five number summary, variance, standard deviation), Measures of shape (skewness, kurtosis), Measures of association (covariance, correlation), Outliers. Using R for descriptive statistics and data visualization using ggplot2 package.

Predictive Analysis using Machine Learning Techniques using R: Machine learning - what, how, where. Supervised, unsupervised and semi-supervised learning. Training, validation, testing, generalization, over fitting. Building a Regression model using R. Features and feature engineering. Using Decision trees, Linear classifiers, Naïve Bayes, Nearest neighbor methods in R packages.

Books:

Text:

- Herbert Schildt, "Java: The Complete Reference" ,TMG Publication, ISBN 9780070636774
- Thomas Powell, "Java generics and collections", O'Reilly Media, ISBN: 0596527756, 2006.
- Peng, Roger D., and Elizabeth Matsui. "The Art of Data Science." A Guide for Anyone Who Works with Data. Skybrude Consulting 200 (2015): 162.
- Evans, James R., and Carl H. Lindner. "Business analytics: the next frontier for decision sciences." Decision Line 43.2 (2012): 4-6.

Reference:

- JAVA EE 7 for Beginners, Sharanam Shah and Vaishali Shah, SPD, ISBN: 13:978-93-5110-349-3
- Data Mining: Concepts and Techniques, Jiawei Han and Micheline Kamber, Morgan Kaufman, ISBN 978-81-312-0535-8
- Learning R, Richard Cotton, O'Reilly, ISBN: 13:978-93-5110-286-1

Suggested List of Laboratory Assignments for Advanced JAVA

- | | |
|----|---|
| 1. | Design a system with the help of advance data structures in Java and enhance the system using |
|----|---|

	collections and generics.
2.	Enhance the above system with the help of socket programming use client server architecture.
3.	Enhance above system by using JDBC, Multithreading, concurrency, synchronous and asynchronous callbacks, Thread Pools using Executor Service.
4.	Transform the above system from command line system to GUI based application

Suggested List of Laboratory Assignments on Data Science with R

1.	Getting Started with R installation, R objects and basic statistics.
2.	Use R for data preprocessing, exploratory analysis, visualization.
3.	Use R for correlation and regression analysis.
4.	Data analysis case study using R for readily available data set using any one machine learning algorithm

Suggested Mini Project on Advanced JAVA and Data Science with R

1. Implementing a simple Recommender System based on user buying pattern.
2. Applying linear regression model to a real world problem.

SD Module-VI Aptitude Development

Quantitative Aptitude, Logical Reasoning and Verbal Ability

An aptitude is a component of a competence to do a certain kind of work at a certain level. Outstanding aptitude can be considered "talent". An aptitude may be physical or mental. Aptitude is inborn potential to do certain kinds of work whether developed or undeveloped. Ability is developed knowledge, understanding, learned or acquired abilities (skills) or attitude. The innate nature of aptitude is in contrast to skills and achievement, which represent knowledge or ability that is gained through learning. (Ref: <https://en.wikipedia.org/wiki/Aptitude>).

Aptitude and ability tests are designed to assess your logical reasoning or thinking performance. The statistics reveal that 70 percent of world's recruitment companies use aptitude test as a part of their recruitment procedure. These types of tests often permit potential companies to learn more about candidate's personality and abilities.

It is well said that aptitude isn't really something one can easily improve, but surely practice can help to improve. Solving number of high level of questions will surely help to succeed while subsequent practices of solving same. Each attempt should aim to attain a level of efficiency. Practice of solving hundreds of similar questions helps to choose right approach to solve.

It is recommended to conduct few expert talks and conduct practice tests for students for minimum 15 minutes per week in current semester and continue in semester VI, VII and VIII.

Text:

1. R.S Aggarwal, "Quantitative Aptitude", S Chand Publisher, ISBN- 9788121924986
2. Aptipedia- Aptitude Encyclopedia, Wiley, ISBN:978-81-265-6223-7
3. Shakuntala Devi, "Puzzles to Puzzle You" and "More Puzzles to Puzzle You", Orient Paperbacks, 2005. ISBN, 8122200141, 9788122200140

Savitribai Phule Pune University
Third Year of Computer Engineering (2015 Course)
310247: Database Management System Lab

Teaching Scheme: Practical : 04 Hours/Week	Credit 02	Examination Scheme: Practical: 50 Marks Term Work: 25 Marks
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Companion Course: Database Management System (310242)

Course Objectives:

- To develop basic, intermediate and advanced Database programming skills
- To develop basic Database administration skills
- To percept transaction processing

Course Outcomes:

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

- Develop the ability to handle databases of varying complexities
- Use advanced database Programming concepts

Guidelines for Instructor's Manual

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

Guidelines for Student Journal

The laboratory assignments are to be submitted by student in the form of journal. Journal consists of prologue, Certificate, table of contents, and **handwritten write-up** of each assignment (Title, Objectives, Problem Statement, Outcomes, software & Hardware requirements, Date of Completion, Assessment grade/marks and assessor's sign, Theory- Concept in brief, 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 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 done based on overall performance and lab assignments performance of student. Each lab assignment assessment will assign grade/marks based on parameters with appropriate weightage. Suggested parameters for overall assessment as well as each lab assignment assessment include- timely completion, performance, innovation, efficient codes, punctuality and neatness.

Guidelines for Practical Examination

Both internal and external examiners should jointly set problem statements. 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. So 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 Laboratory Conduction

The instructor is expected to frame the assignments by understanding the prerequisites,

technological aspects, utility and recent trends related to the topic. The assignment framing policy need to address the average students and inclusive of an element to attract and promote the intelligent students. The instructor may set multiple sets of assignments and distribute among batches of students. It is appreciated if the assignments are based on real world problems/applications. Encourage students for appropriate use of Hungarian notation, proper indentation and comments. Use of open source software is to be encouraged.

In addition to these, instructor may assign one real life application in the form of a mini-project based on the concepts learned. Instructor may also set one assignment or mini-project that is suitable to respective branch beyond the scope of syllabus.

Set of suggested assignment list is provided in groups- A and B. Each student must perform at least 13 assignments (8-Mandatory plus 4 from remaining 8 assignments) from group A , 5 from group B and 2 mini projects from Group C

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

Programming tools recommended: SQL, PL/SQL, Front End: Java/Perl/PHP/Python/Ruby/.net, Backend : Monod/MYSQL/Oracle, Database Connectivity : ODBC/JDBC

Books:

References:

1. Ivan Bayross, "SQL, PL/SQL: The Programming Language of Oracle", BPB Publication, ISBN-10: 8176560723; ISBN-13: 978-8176560726
2. Kristina Chodorow, Michael Dirolf, "MongoDB: The Definitive Guide", O'Reilly Publications, ISBN: 9781449381561
3. Import, Tidy, Transform," R for Data Science", O'REILLY, ISBN: 13:978-93-5213-497-7
4. <http://www.tutorialspoint.com/json/> & <http://docs.mongodb.org/manual/>

Suggested List of Laboratory Assignments

Group A- Database Programming Languages – SQL, PL/SQL

1. Study of Open Source Relational Databases : MySQL
2. Design and Develop SQL DDL statements which demonstrate the use of SQL objects such as Table, View, Index, Sequence, Synonym
3. Design at least 10 SQL queries for suitable database application using SQL DML statements: Insert, Select, Update, Delete with operators, functions, and set operator.
4. Design at least 10 SQL queries for suitable database application using SQL DML statements: all types of Join, Sub-Query and View.
5. Unnamed PL/SQL code block: Use of Control structure and Exception handling is mandatory. Write a PL/SQL block of code for the following requirements:-
Schema:
 1. Borrower(Rollin, Name, DateofIssue, NameofBook, Status)
 2. Fine(Roll_no,Date,Amt)
 - Accept roll_no & name of book from user.
 - Check the number of days (from date of issue), if days are between 15 to 30 then fine amount will be Rs 5per day.
 - If no. of days>30, per day fine will be Rs 50 per day & for days less than 30, Rs. 5 per day.
 - After submitting the book, status will change from I to R.
 - If condition of fine is true, then details will be stored into fine table.

Frame the problem statement for writing PL/SQL block inline with above statement.
6. Cursors: (All types: Implicit, Explicit, Cursor FOR Loop, Parameterized Cursor)
Write a PL/SQL block of code using parameterized Cursor, that will merge the data available in the newly created table N_RollCall with the data available in the table O_RollCall. If the data in the first table already exist in the second table then that data should be skipped.
Frame the separate problem statement for writing PL/SQL block to implement all types

	of Cursors inline with above statement. The problem statement should clearly state the requirements.
7.	<p>PL/SQL Stored Procedure and Stored Function.</p> <p>Write a Stored Procedure namely proc_Grade for the categorization of student. If marks scored by students in examination is ≤ 1500 and $\text{marks} \geq 990$ then student will be placed in distinction category if marks scored are between 989 and 900 category is first class, if marks 899 and 825 category is Higher Second Class</p> <p>Write a PL/SQL block for using procedure created with above requirement.</p> <p>Stud_Marks(name, total_marks) Result(Roll,Name, Class)</p> <p>Frame the separate problem statement for writing PL/SQL Stored Procedure and function, inline with above statement. The problem statement should clearly state the requirements.</p>
8.	<p>Database Trigger (All Types: Row level and Statement level triggers, Before and After Triggers). Write a database trigger on Library table. The System should keep track of the records that are being updated or deleted. The old value of updated or deleted records should be added in Library_Audit table.</p> <p>Frame the problem statement for writing Database Triggers of all types, in-line with above statement. The problem statement should clearly state the requirements.</p>
Group B Large Scale Databases	
1.	Study of Open Source NOSQL Database: MongoDB (Installation, Basic CRUD operations, Execution)
2.	Design and Develop MongoDB Queries using CRUD operations. (Use CRUD operations, SAVE method, logical operators)
3.	Implement aggregation and indexing with suitable example using MongoDB.
4.	Implement Map reduces operation with suitable example using MongoDB.
5.	Design and Implement any 5 query using MongoDB
6.	Create simple objects and array objects using JSON
7.	Encode and Decode JSON Objects using Java/Perl/PHP/Python/Ruby
Group C Mini Project : Database Project Life Cycle	
1.	Write a program to implement MogoDB database connectivity with PHP/ python/Java Implement Database navigation operations (add, delete, edit etc.) using ODBC/JDBC.
2.	Implement MYSQL/Oracle database connectivity with PHP/ python/Java Implement Database navigation operations (add, delete, edit,) using ODBC/JDBC.
3.	<p>Using the database concepts covered in Part-I & Part-II & connectivity concepts covered in Part C, students in group are expected to design and develop database application with following details:</p> <p>Requirement Gathering and Scope finalization</p> <p>Database Analysis and Design:</p> <ul style="list-style-type: none"> Design Entity Relationship Model, Relational Model, Database Normalization <p>Implementation :</p> <ul style="list-style-type: none"> Front End : Java/Perl/PHP/Python/Ruby/.net Backend : MongoDB/MYSQL/Oracle Database Connectivity : ODBC/JDBC <p>Testing : Data Validation</p> <p>Group of students should submit the Project Report which will be consist of documentation related to different phases of Software Development Life Cycle: Title of the Project, Abstract, Introduction, scope, Requirements, Data Modeling features, Data Dictionary, Relational Database Design, Database Normalization, Graphical User Interface, Source Code, Testing document, Conclusion. Instructor should maintain progress report of mini project throughout the semester from project group and assign marks as a part of the term work</p>

Savitribai Phule Pune University
Third Year of Computer Engineering (2015 Course)
310248: Computer Networks Lab

Teaching Scheme: PR: 02 Hours/Week	Credit 01	Examination Scheme: TW: 25 Marks PR: 50 Marks
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Companion Course: 310245 Computer Networks (CN)

Course Objectives:

- To establish communication among the computing nodes in P2P and Client-Server architecture
- Configure the computing nodes with understanding of protocols and technologies.
- Use different communicating modes and standards for communication
- Use modern tools for network traffic analysis
- To learn network programming.

Course Outcomes:

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

- Demonstrate LAN and WAN protocol behavior using Modern Tools.
- Analyze data flow between peer to peer in an IP network using Application, Transport and Network Layer Protocols.
- Demonstrate basic configuration of switches and routers.
- Develop Client-Server architectures and prototypes by the means of correct standards and technology.

Guidelines for Instructor's Manual

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

Guidelines for Student Journal

The laboratory assignments are to be submitted by student in the form of journal. Journal consists of prologue, Certificate, table of contents, and **handwritten write-up** of each assignment (Title, Objectives, Problem Statement, Outcomes, software & Hardware requirements, Date of Completion, Assessment grade/marks and assessor's sign, Theory- Concept in brief, algorithm, flowchart, 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 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 done based on overall performance and lab assignments performance of student. Each lab assignment assessment will assign grade/marks based on parameters with appropriate weightage. Suggested parameters for overall assessment as well as each lab assignment assessment include- timely completion, performance, innovation, efficient codes, punctuality and neatness.

Guidelines for Practical Examination

Both internal and external examiners should jointly set problem statements. 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. So 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 Laboratory Conduction

The instructor is expected to frame the assignments by understanding the prerequisites, technological aspects, utility and recent trends related to the topic. The assignment framing policy need to address the average students and inclusive of an element to attract and promote the intelligent students. The instructor may set multiple sets of assignments and distribute among batches of students. It is appreciated if the assignments are based on real world problems/applications. Encourage students for appropriate use of Hungarian notation, proper indentation and comments. Use of open source software is to be encouraged.

In addition to these, instructor may assign one real life application in the form of a mini-project based on the concepts learned. Instructor may also set one assignment or mini-project that is suitable to respective branch beyond the scope of syllabus.

Set of suggested assignment list is provided in groups- A and B. Each student must perform at least 8 assignments (4-Mandatory plus 4 from remaining 8 assignments) from group A and 4 from group B (2-Mandatory plus 2 from remaining 5 assignments).

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

Programming tools recommended: - Open Source C,C++, JAVA, PYTHON,
Programming tool like G++/GCC, Wireshark, Etheral and Packet Tracer

Books:

References:

1. Thomas D. Nadean and Ken Gray, "Software Defined Networks", O'REILLY, ISBN: 13:978-93-5110-264-9
2. Robert Faludi, "Building Wireless Sensor Networks", O'REILLY, ISBN: 13:978-93-5023-289-7

Suggested List of Laboratory Assignments

Group A

All assignments should be implemented using Open Source Linux flavors, Open Source Tools: Wireshark and Packet Tracer and C/C++, JAVA, PYTHON.

1. **Lab Assignment on Unit I: (Mandatory Assignment)**
Part A: Setup a wired LAN using Layer 2 Switch and then IP switch of minimum four computers. It includes preparation of cable, testing of cable using line tester, configuration machine using IP addresses, testing using PING utility and demonstrate the PING packets captured traces using Wireshark Packet Analyzer Tool.
Part B: Extend the same Assignment for Wireless using Access Point
2. **Lab Assignment on Unit II: (Use C/C++)**
 Write a Program with following four options to transfer-
 - a. Characters separated by space
 - b. One Strings at a time
 - b. One Sentence at a time
 - c. file
 between two RS 232D or USB ports using C/C++. (To demonstrate Framing, Flow control, Error control).

3.	Lab Assignment on Unit II: (Use C/C++) Write a program for error detection and correction for 7/8 bits ASCII codes using Hamming Codes or CRC. Demonstrate the packets captured traces using Wireshark Packet Analyzer Tool for peer to peer mode.(50% students will perform Hamming Code and others will perform CRC)
4.	Lab Assignment on Unit II: (Use JAVA/PYTHON) Write a program to simulate Go back N and Selective Repeat Modes of Sliding Window Protocol in peer to peer mode and demonstrate the packets captured traces using Wireshark Packet Analyzer Tool for peer to peer mode.
5.	Lab Assignment on Unit IV: (Use JAVA/PYTHON) Write a program to demonstrate subnetting and find the subnet masks.
6.	Lab Assignment on Unit IV: (Use JAVA/PYTHON) Write a program to simulate the behavior of link state routing protocol to find suitable path for transmission.
7.	Lab Assignment on Unit V: (Mandatory Assignment) (Use C/C++) Write a program using TCP socket for wired network for following <ol style="list-style-type: none"> Say Hello to Each other (For all students) File transfer (For all students) Calculator (Arithmetic) (50% students) Calculator (Trigonometry) (50% students) Demonstrate the packets captured traces using Wireshark Packet Analyzer Tool for peer to peer mode.
8.	Lab Assignment on Unit V: (Mandatory Assignment) (Use C/C++) Write a program using UDP Sockets to enable file transfer (Script, Text, Audio and Video one file each) between two machines. Demonstrate the packets captured traces using Wireshark Packet Analyzer Tool for peer to peer mode.
9.	Lab Assignment on Unit V: (Mandatory Assignment) (Use C/C++) Write a program to analyze following packet formats captured through Wireshark for wired network. 1. Ethernet 2. IP 3. TCP 4. UDP
10.	Write a program to simulate the behavior of Slow Start and AIMD (Additive Increase and Multiplicative Decrease) congestion control protocols. (Use JAVA/PYTHON)
11.	Lab Assignment on Unit VI: (Use JAVA/PYTHON) Write a program for DNS lookup. Given an IP address input, it should return URL and vice-versa.
12.	Lab Assignment on Unit VI: Installing and configure DHCP server and write a program to install the software on remote machine.
Group B	
1.	Lab Assignment on Unit II: (Use JAVA/PYTHON) Write a Program to transfer- By using Bluetooth <ol style="list-style-type: none"> Characters separated by space One Strings at a time One Sentence at a time File
2.	Lab Assignment on Unit IV: (Use JAVA/PYTHON) Study of any network simulation tools - To create a network with three nodes and establish a TCP connection between node 0 and node 1 such that node 0 will send TCP packet to node 2 via node 1
3.	Lab Assignment on Unit V: (Use JAVA/PYTHON) Write a program using TCP sockets for wired network to implement <ol style="list-style-type: none"> Peer to Peer Chat Multiuser Chat

	Demonstrate the packets captured traces using Wireshark Packet Analyzer Tool for peer to peer mode.
4.	Lab Assignment on Unit V: (Use JAVA/PYTHON) Write a program using UDP sockets for wired network to implement <ol style="list-style-type: none">Peer to Peer ChatMultiuser Chat Demonstrate the packets captured traces using Wireshark Packet Analyzer Tool for peer to peer mode.
5.	Lab Assignment on Unit V: (Use JAVA/PYTHON) Write a program to prepare TCP and UDP packets using header files and send the packets to destination machine in peer to peer mode. Demonstrate the packets captured traces using Wireshark Packet Analyzer Tool for peer to peer mode.
6.	Lab Assignment on Unit IV and Unit V: (Mandatory Assignment) Use network simulator NS2 to implement: <ol style="list-style-type: none">Monitoring traffic for the given topologyAnalysis of CSMA and Ethernet protocolsNetwork Routing: Shortest path routing, AODV.Analysis of congestion control (TCP and UDP).
7.	Lab Assignment on Unit IV: (Mandatory Assignment) Configure RIP/OSPF/BGP using packet Tracer.

Savitribai Phule Pune University
Third Year of Computer Engineering (2015 Course)
310249: Audit Course 3

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/revise-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)

- | | |
|---|--|
| <ul style="list-style-type: none"> • Lectures/ Guest Lectures • Visits (Social/Field) and reports • Demonstrations | <ul style="list-style-type: none"> • Surveys • Mini Project • Hands on experience on specific focused topic |
|---|--|

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

- | | |
|---|---|
| <ul style="list-style-type: none"> • Written Test • Demonstrations/ Practical Test • Presentations | <ul style="list-style-type: none"> • IPR/Publication • Report |
|---|---|

Audit Course 3 Options

AC3- I	Cyber Security
AC3-II	Professional Ethics and Etiquettes
AC3-III	Emotional Intelligence
AC3-IV	MOOC-Learn New Skills
AC3-V	Foreign Language (one of Japanese/ Spanish/French/German). Course contents for Japanese (Module 3) are provided. For other languages institute may design suitably.

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
Third Year of Computer Engineering (2015 Course)
310249: Audit Course 3
AC3 – I: Cyber Security

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 assess the current security landscape, including the nature of the threat, the general status of common vulnerabilities, and the likely consequences of security failures;
- To critique and assess the strengths and weaknesses of general cyber security models, including the CIA triad
- To appraise the interrelationships among elements that comprise a modern security system, including hardware, software, policies, and people;
- To assess how all domains of security interact to achieve effective system-wide security at the enterprise level.

Course Outcome:

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

- Compare the interrelationships among security roles and responsibilities in a modern information-driven enterprise—to include interrelationships across security domains (IT, physical, classification, personnel, and so on)
- Assess the role of strategy and policy in determining the success of information security;
- Estimate the possible consequences of misaligning enterprise strategy, security policy, and security plans;

Course Contents:

- 1. Cyber Security Basics:** Introduction, Elements of Information security, Security Policy, Techniques, Operational Model of Network Security, Terminologies in Network Security
- 2. Introduction to Cryptography:** Introduction, Encryption Methods: Symmetric, Asymmetric, Public Key and Management, Authentication methods, Digital Signatures
- 3. Security requirements:** Electronic Mail Security: Pretty Good Privacy, MIME, S/MIME, And Comparison. WEB Security, Secure Electronic Transaction(SET).
- 4. Intrusion and Firewall:** Introduction to threats, Intrusion detection, IDS: Need, Methods, Types of IDS, Password Management, Limitations and Challenges, Firewall Introduction, Characteristics and types, Benefits and limitations. Firewall architecture, Trusted Systems, Access Control
- 5. Security perspective of Hacking and its counter majors :** Introduction to Hacking, Counter majors: General Strategies

Books:

1. William Stallings, “Cryptography and Network Security”, Pearson, ISBN:978-93-325-1877-3
2. Oded Goldreich, “Foundations of Cryptography: Basic Tools”, Cambridge University Press, ISBN-10: 0521035368; ISBN-13: 978-0521035361
3. Jonathan Katz and Yehuda Lindell, “Introduction to Modern Cryptography”, CRC Book

Savitribai Phule Pune University, Pune
Third Year of Computer Engineering (2015 Course)
310249: Audit Course 3
AC3 – II: Professional Ethics and Etiquettes

Professional ethics is the underlying concept behind the successful accomplishment of any act of a professional towards achieving the individual and societal goals. These goals should ultimately result in morally, legally, ethically and even culturally acceptable good things for all. Engineers being special group of professionals need to be more conscious of their acts since their duties, rights and responsibilities permeate into the society and the surroundings. To practice professional ethics, understanding of values and concepts are essential.

Course Objectives:

- To create awareness on professional ethics and Human Values.
- To provide basic familiarity about Engineers as responsible Experimenters, Research Ethics, Codes of Ethics, Industrial Standards.
- To inculcate knowledge and exposure on Safety and Risk.
- To expose students to right attitudinal and behavioral aspects

Course Outcome:

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

- understand the basic perception of profession, professional ethics, various moral issues & uses of ethical theories
- Understand various social issues, industrial standards, code of ethics and role of professional ethics in engineering field.
- Follow Ethics as an engineering professional and adopt good standards & norms of engineering practice.
- apply ethical principles to resolve situations that arise in their professional lives

Course Contents:

- 1. Human Values And Engineering Ethics:** Morals, values and Ethics, Integrity, Work ethic, Civic virtue , Valuing time, Cooperation, Commitment, Empathy, Self-confidence , stress management, Senses of Engineering Ethics, Kohlberg’s theory, Gilligan’s theory, Models of professional roles, Uses of Ethical Theories.
- 2. Research Ethics and Codes of Ethics:** Industrial standardization, ethical code and its importance, ethical accountability, law in engineering, engineering as social experimentation.
- 3. Safety, Responsibilities And Rights:** Safety and Risk, Assessment of Safety and Risk, Risk Benefit Analysis and Reducing Risk collegiality, Collective Bargaining , Confidentiality , Conflicts of Interest, Professional Rights, Employee Rights, Intellectual Property Rights (IPR), Discrimination, Utilitarianism
- 4. Professional Etiquette:** Etiquette at Meetings, Public Relations Office(PRO)’s Etiquettes, Technology Etiquette Phone Etiquette, Email Etiquette, Social Media Etiquette, Video Conferencing Etiquette, Interview Etiquette, Dressing Etiquettes : for Interview, offices and social functions, Ethical Values: Importance of Work Ethics.

Books:

1. Caroline Whitbeck, “Ethics in Engineering Practice and Research”, Cambridge Press, ISBN:978-1-107-66847-8
2. Prabhuddha Ganguli: —Intellectual Property Rights| Tata Mc-Graw –Hill, New Delhi, ISBN-10:0070077177
3. Professional Ethics and Etiquette (Mastering Career Skills), Checkmark, ISBN-10: 0816071179
4. A Alavudeen, ”Professional Ethics And Human Values” Firewall, ISBN13 : 8131803066

Savitribai Phule Pune University, Pune
Third Year of Computer Engineering (2015 Course)
310249: Audit Course 3
AC3 – III: 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 your leadership effectiveness by creating an atmosphere that engages others
- Apply EI behaviors and supports high performance

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)
310249: Audit Course 3
AC3 – IV: 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 Outcome:

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: These are NPTEL for engineering and UGC for post-graduation education.

Guidelines:

Instructor is requested to promote students to opt for courses with proper mentoring. The departments will take care of providing necessary infrastructural facilities and other facilities for the learners.

References:

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

Savitribai Phule Pune University, Pune
Third Year of Computer Engineering (2015 Course)
310249: Audit Course 3
AC3 – V: Foreign Language(Japanese Module 3)

Prerequisite Courses: Audit Course AC1-V(210250), AC2-V(210258)

About Course:

With changing times, the competitiveness has gotten into the nerves and ‘Being the Best’ at all times is only the proof of it. Nonetheless, ‘being the best’ differs significantly from ‘Communicating the best’. The best can merely be communicated whilst using the best suited Language!

Japanese is the new trend of 21st century. Not only youngsters but even the professionals seek value in it. It is the engineer’s companion in current times with an assertion of a thriving future. Pune has indisputably grown to become a major center of Japanese Education in India while increasing the precedence for Japanese connoisseurs.

Japanese certainly serves a great platform to unlock a notoriously tough market & find a booming career. While the companies prefer candidates having the knowledge of the language, it can additionally help connect better with the native people thus prospering in their professional journey. Learning Japanese gives an extra edge to the ‘resume’ since the recruiters consciously make note of the fact it requires real perseverance and self-discipline to tackle one of the most complex languages.

It would be easy for all time to quit the impossible; however it takes immense courage to reiterate the desired outcomes, recognize that improvement is an ongoing process and ultimately soldier on it. The need of an hour is to introduce Japanese language with utmost professionalism to create awareness about the bright prospects and to enhance the proficiency and commitment. It will then prove to be the ultimate path to the quest for professional excellence!

Course Objectives:

- To meet the needs of ever growing industry with respect to language support.
- To get introduced to Japanese society and culture through language.

Course Outcome:

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

- Have ability of basic communication.
- Have the knowledge of Japanese script.
- Get introduced to reading, writing and listening skills for language Japanese.
- Develop interest to pursue professional Japanese Language course

Course Contents:

1. Introduction to Kanji Script, Describing one’s daily routine. To ask what someone does. Expressions of Giving & Receiving.
2. Adjectives (Types of adjectives), Asking impression or an opinion about a thing / person / place that the listener, has experienced, visited, or met, Describing things / person / places with the help of the adjectives.
3. Expressions of Like & Dislikes. Expressing one’s ability, hobby, Comparison between objects, persons & cities, which resulted from a certain action in the past.

References:

1. Minna No Nihongo, —Japanese for Everyone!, Elementary Main Text book 1-1 (Indian Edition), Goyal Publishers & Distributors Pvt. Ltd.
2. <http://www.tcs.com> (http://www.tcs.com/news_events/press_releases/Pages/TCS-Inaugurates-Japan-centric-Delivery-Center-Pune.aspx)

SEMESTER II

Savitribai Phule Pune University Third Year of Computer Engineering (2015 Course) 310250: Design and Analysis of Algorithms		
Teaching Scheme: TH: 04 Hours/Week	Credit 04	Examination Scheme: In-Sem (Paper): 30 Marks End-Sem (Paper): 70 Marks
Prerequisite Courses: Discrete Mathematics (210241), Data Structures (210243, 210252), Theory of Computation (310241)		
Course Objectives: <ul style="list-style-type: none"> • To develop problem solving abilities using mathematical theories • To analyze the performance of algorithms • To study algorithmic design strategies 		
Course Outcomes: On completion of the course, student will be able to– <ul style="list-style-type: none"> • Formulate the problem • Analyze the asymptotic performance of algorithms • Decide and apply algorithmic strategies to solve given problem • Find optimal solution by applying various methods 		
Course Contents		
Unit I	Fundamentals	09 Hours
The Role of Algorithms in Computing - What are algorithms, Algorithms as technology, Evolution of Algorithms, Design of Algorithm, Need of Correctness of Algorithm, Confirming correctness of Algorithm – sample examples, Iterative algorithm design issues.		
Unit II	Models and Design	09 Hours
Functional Model – Features, Recursive processes, Scope rules, Tail recursion, Checking correctness of Iterative process. Imperative Model – Basics, Specifications and Prototyping, Stepwise Refinement, Proof Rules – Basics, For loops, Goto and Exit loops, Functions and Procedures, Problem Solving using Greedy strategy - Knapsack problem, Huffman code generation algorithm.		
Unit III	Abstract Algorithms	09 Hours
Dynamic Programming, Divide and Conquer, Greedy strategy, Branch-n-Bound, Natural Algorithms –Evolutionary Algorithms and Evolutionary Computing, Introduction to Genetic Algorithm, Simulated Annealing, Artificial Neural Network and Tabu Search.		
Unit IV	Complexity Theory	09 Hours
Complexity theory – Counting Dominant operators, Growth rate, upper bounds, asymptotic growth, O, Ω , Θ , o and ω notations, polynomial and non-polynomial problems, deterministic and non-deterministic algorithms, P-class problems, NP-class of problems, Polynomial problem reduction NP complete problems- vertex cover and 3-SAT and NP hard problem - Hamiltonian cycle.		
Unit V	Amortized Analysis	09 Hours

Amortized Analysis – Binary, Binomial and Fibonacci heaps, Dijkstra’s Shortest path algorithm, Splay Trees, Time-Space tradeoff, Introduction to Tractable and Non-tractable Problems, Introduction to Randomized and Approximate algorithms, Embedded Algorithms: Embedded system scheduling (power optimized scheduling algorithm), sorting algorithm for embedded systems.

Unit VI	Multithreaded and Distributed Algorithms	09 Hours
<p>Multithreaded Algorithms - Introduction, Performance measures, Analyzing multithreaded algorithms, Parallel loops, Race conditions.</p>		
<p>Problem Solving using Multithreaded Algorithms - Multithreaded matrix multiplication, Multithreaded merge sort.</p>		
<p>Distributed Algorithms - Introduction, Distributed breadth first search, Distributed Minimum Spanning Tree.</p>		
<p>String Matching- Introduction, The Naive string matching algorithm, The Rabin-Karp algorithm</p>		
<p>Books:</p>		
<p>Text:</p> <ol style="list-style-type: none"> 1. Parag Himanshu Dave, Himanshu Bhalchandra Dave, “Design And Analysis of Algorithms”, Pearson Education, ISBN 81-7758-595-9 2. Gilles Brassard, Paul Bratley, “Fundamentals of Algorithmics”, PHI, ISBN 978-81-203-1131-2 		
<p>References:</p> <ol style="list-style-type: none"> 1. Michael T. Goodrich, Roberto Tamassia , “Algorithm Design: Foundations, Analysis and Internet Examples”, Wiley, ISBN 978-81-265-0986-7 2. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, “Introduction to Algorithms”, MIT Press; ISBN 978-0-262-03384-8 3. Horowitz and Sahani, "Fundamentals of Computer Algorithms", University Press, ISBN: 978 81 7371 6126, 81 7371 61262 4. Rajeev Motwani and Prabhakar Raghavan, “Randomized Algorithms”, Cambridge University Press, ISBN: 978-0-521-61390-3 5. Dan Gusfield, “Algorithms on Strings, Trees and Sequences”, Cambridge University Press,ISBN:0-521-67035-7 		

Savitribai Phule Pune University Third Year of Computer Engineering (2015 Course) 310251: Systems Programming and Operating System		
Teaching Scheme: TH: 04 Hours/Week	Credit 04	Examination Scheme: In-Sem (Paper): 30 Marks End-Sem (Paper): 70 Marks
Prerequisite Courses: Fundamentals of Programming Languages(110011,110003), Data Structures (210243,210252)		
Companion Course: Systems Programming and Operating System Lab (310257)		
Course Objectives: <ul style="list-style-type: none"> • To understand basics of System Programming. • To learn and understand data structures used in design of system software. • To learn and understand basics of compilers and tools. • To understand functions of operating system. • To learn and understand process, resource and memory management. 		
Course Outcomes: On completion of the course, student will be able to– <ul style="list-style-type: none"> • Analyze and synthesize system software • Use tools like LEX & YACC. • Implement operating system functions. 		
Course Contents		
Unit I	Introduction	09 Hours
Introduction: Components of System Software: Text editors, Loaders, Assemblers, Macro processors, Compilers, Debuggers. Machine Structure, Machine language and Assembly Language. Assemblers: General design procedure, design of two pass assembler		
Unit II	Macro Processor, Linker and Loader	09 Hours
Macro Processor: Macro instructions, Features of macro facility, Design of two-pass, single pass and nested macro processor. Loaders: Loader schemes: Compile and go, General Loader Scheme, Absolute loaders, subroutine linkages, relocating loaders, direct linking loaders, overlay structure. Design of an absolute loader, Design of direct linking loader. Linkers: Relocation and linking concepts, Design of linker, self relocating programs, Static and dynamic link libraries, use of call back functions. Case Study: Loading phases using Java.		
Unit III	Language Translator	09 Hours
Role of lexical analysis -parsing & Token, patterns and Lexemes & Lexical Errors, regular definitions for the language constructs & strings, sequences, Comments & Transition diagram for recognition of tokens, reserved words and identifiers, examples Introduction to Compilers and Interpreters: General Model of Compiler, Program interpretation, Comparison of compiler and Interpreter, Use of Interpreter and components of Interpreter. Case Study: Overview of LEX and YACC specification and features.		
Unit IV	Operating Systems	09 Hours

Operating Systems: Introduction to different types of operating Real Time Operating Systems, System Components, OS services, System structure- Layered Approach.

Process Management: Process Concept- Process states, Process control block, Threads, Process Scheduling: Types of process schedulers, Types of scheduling: Preemptive, Non preemptive. Scheduling algorithms: FCFS, SJF, RR, Priority,

Deadlocks: Methods of handling deadlocks, Deadlock prevention, avoidance and detection, Recovery from deadlocks.

Case Study: Process Management in multi-cores OS.

Unit V	Memory Management	09 Hours
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Memory management: Review of Programming Model of Intel 80386, Contiguous and non-contiguous, Swapping, Paging, Segmentation, Segmentation with Paging. Virtual Memory: Background, Demand paging, Page replacement scheme- FIFO, LRU, Optimal, Thrashing.

Case Study: Memory Management in multi-cores OS.

Unit VI	I/O Management	09 Hours
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I/O Management: I/O Devices, Organization of I/O function, I/O Buffering, Disk Scheduling- Disk Scheduling policies like FIFO, LIFO, STTF, SCAN, C-SCAN.

File Management: Concept, Access methods, Directory Structure, Protection, File System implementation, Directory Implementation, Allocation methods, Free Space management.

Case Study: I/O and File Management in multi-cores OS

Case Study: Light weight and heavy weight OS: Linux, Tizen

Books:

Text:

1. John Donovan, "System Programming", McGraw Hill, ISBN 978-0--07-460482-3.
2. Silberschatz, Galvin, Gagne, "Operating System Principles", 9th Edition, Wiley, ISBN 978-1-118-06333-0

References:

1. Dhamdhere D., "Systems Programming and Operating Systems", McGraw Hill, ISBN 0 - 07 - 463579 – 4
2. Randal Bryant and David O'Hallaron, "Computer Systems: A Programmer's Perspective", Pearson, ISBN 10: 0-13-610804-0
3. Stallings W., "Operating Systems", 6th Edition, Prentice Hall, ISBN-978-81-317-2528-3.
4. John. R. Levine, Tony Mason and Doug Brown, "Lex and Yacc", O'Reilly, 1998, ISBN: 1-56592-000-7

Savitribai Phule Pune University Third Year of Computer Engineering (2015 Course) 310252: Embedded Systems and Internet of Things		
Teaching Scheme: TH: 04 Hours/Week	Credit 04	Examination Scheme: In-Sem (Paper): 30 Marks End-Sem (paper): 70 Marks
Prerequisite Course: Computer Networks (310245)		
Companion Course: Embedded Systems and IoT Lab (310258)		
Course Objectives:		
<ul style="list-style-type: none"> • To understand fundamentals of IoT and embedded system including essence, basic design strategy and process modeling. • To introduce students a set of advanced topics in embedded IoT and lead them to understand research in network. • To develop comprehensive approach towards building small low cost embedded IoT system. • To understand fundamentals of security in IoT, • To learn to implement secure infrastructure for IoT • To learn real world application scenarios of IoT along with its societal and economic impact using case studies 		
Course Outcomes:		
On completion of the course, student will be able to–		
<ul style="list-style-type: none"> • Implement an architectural design for IoT for specified requirement • Solve the given societal challenge using IoT • Choose between available technologies and devices for stated IoT challenge 		
Course Contents		
Unit I	Introduction to Embedded System and Internet of Things	09 Hours
Embedded Systems: Application Domain and Characteristic of Embedded System, Real time systems and Real time scheduling, Processor basics and System-On-Chip, Introduction to ARM processor and its architecture. IoT: Definition and characteristics of IoT, Internet of Things: Vision, Emerging Trends, Economic Significance, Technical Building Blocks, Physical design of IoT, Things of IoT, IoT Protocols, Logical design of IoT, IoT functional blocks, IoT communication models, IoT Communication APIs, IoT enabling technologies, IoT levels and deployment templates, IoT Issues and Challenges, Applications		
Unit II	Embedded IoT Platform Design Methodology	09 Hours
Purpose and requirement specification, Process specification, Domain model specification, information model specification, Service specifications, IoT level specification, Functional view specification, Operational view specification, Device and component integration, Application development		
Unit III	Pillars of Embedded IoT and Physical Devices	09 Hours
Horizontal, verticals and four pillars of IoT, M2M: The internet of devices, RFID: The internet of objects, WSN: The internet of transducer, SCADA: The internet of controllers, DCM: Device, Connect and Manage, Device: Things that talk, Connect: Pervasive Network, Mangae: To create business values. IoT Physical Devices and Endpoints: Basic building blocks of and IoT device, Exemplary device: Raspberry Pi, Raspberry Pi interfaces, Programming Raspberry Pi with Python, Beagle board and Other IoT Devices.		

Unit IV	IoT Protocols and Security	09 Hours
<p>Protocol Standardization for IoT, Efforts, M2M and WSN Protocols, SCADA and RFID Protocols, Issues with IoT Standardization, Unified Data Standards, Protocols – IEEE 802.15.4, BACNet Protocol, Modbus, KNX, Zigbee Architecture, Network layer, APS layer.</p> <p>IoT Security: Vulnerabilities of IoT, Security Requirements, Challenges for Secure IoT, Threat Modeling, Key elements of IoT Security: Identity establishment, Access control, Data and message security, Non-repudiation and availability, Security model for IoT.</p>		
Unit V	Web of Things and Cloud of Things	09 Hours
<p>Web of Things versus Internet of Things, Two Pillars of the Web, Architecture Standardization for WoT, Platform Middleware for WoT, Unified Multitier WoT Architecture, WoT Portals and Business Intelligence. Cloud of Things: Grid/SOA and Cloud Computing, Cloud Middleware, Cloud Standards – Cloud Providers and Systems, Mobile Cloud Computing, The Cloud of Things Architecture.</p>		
Unit VI	IoT Physical Servers, Cloud Offerings and IoT Case Studies	09 Hours
<p>Introduction to Cloud Storage Models, Communication API, WAMP: AutoBahn for IoT, Xively Cloud for IoT, Python Web Application Framework: Django, Amzon Web Services for IoT, SkyNet IoT Messaging Platform. Case Studies: Home Intrusion Detection, Weather Monitoring System, Air Pollution Monitoring, Smart Irrigation.</p>		
<p>Books:</p>		
<p>Text:</p> <ol style="list-style-type: none"> 1. Arshdeep Bahga, Vijay Madiseti, “Internet of Things – A hands-on approach”, Universities Press, ISBN: 0: 0996025510, 13: 978-0996025515 2. Honbo Zhou, “The Internet of Things in the Cloud: A Middleware Perspective”, CRC Press, 2012. ISBN : 9781439892992 3. Dieter Uckelmann, Mark Harrison, Florian Michahelles, “Architecting the Internet of Things”, Springer, 2011. ISBN: 978-3-642-19156-5 4. Lyla B. Das, “Embedded Systems: An Integrated Approach” Pearson , ISBN: 9332511675, 9789332511675. 		
<p>References:</p> <ol style="list-style-type: none"> 1. David Easley and Jon Kleinberg, “Networks, Crowds, and Markets: Reasoning About a Highly Connected World”, Cambridge University Press, 2010, ISBN:10: 0521195330 2. Olivier Hersent, Omar Elloumi and David Boswarthick, “The Internet of Things: Applications to the Smart Grid and Building Automation”, Wiley, 2012, 9781119958345 3. Olivier Hersent, David Boswarthick, Omar Elloumi , “The Internet of Things – Key applications and Protocols”, Wiley, 2012, ISBN:978-1-119-99435-0 4. Barrie Sosinsky, “Cloud Computing Bible”, Wiley-India, 2010.ISBN : 978-0-470-90356-8 5. Adrian McEwen, Hakim Cassimally, “Designing the Internet of Things”, Wiley, 2014, ISBN: 978-1-118-43063-7 6. Christopher Hallinan, “Embedded Linux Primer”, Prentice Hall, ISBN:13: 978-0-13-167984-9 		

Savitribai Phule Pune University
Third Year of Computer Engineering (2015 Course)
310253: Software Modeling and Design

Teaching Scheme: TH: 03 Hours/Week	Credits 03	Examination Scheme: In-Sem (Paper): 30 Marks End-Sem (Paper): 70 Marks
Prerequisite Course: Software Engineering and Project Management (310243)		
Course Objectives: <ul style="list-style-type: none"> • To understand and apply Object Oriented(OO) concept for designing OO based model/application • To transform Requirement document to Appropriate design • To understand different architectural designs and to transform them into proper model • To choose and use modern design tools for project development and implementation. • To choose and use appropriate test tool for testing web-based/desktop application 		
Course Outcomes: On completion of the course, student will be able to– <ul style="list-style-type: none"> • Analyze the problem statement (SRS) and choose proper design technique for designing web-based/ desktop application • Design and analyze an application using UML modeling as fundamental tool • Apply design patterns to understand reusability in OO design • Decide and apply appropriate modern tool for designing and modeling • Decide and apply appropriate modern testing tool for testing web-based/desktop application 		
Course Contents		
Unit I	Introduction	07 Hours
Introduction to software design, design methods- procedural / structural and object oriented, Requirement Vs Analysis Vs Architecture Vs Design Vs Development 4+1 Architecture, case study of transferring requirement to design, UP, COMET use case based software life cycle, Introduction to UML -Basic building blocks, Reusability, Use case modeling, Use case template Case study – Transferring requirements into design using advanced tool		
Unit II	Static Modelling	08 Hours
Analysis Vs Design, Class diagram- Analysis - Object & classes finding analysis & Design- design classes, refining analysis relationships, Inheritance & polymorphism, Object diagram, Component diagram- Interfaces & components, deployment diagram, Package diagram		
Unit III	Dynamic Modelling	07 Hours
Interaction & Interaction overview diagram, sequence diagram, Timing diagram, Communication diagram, Advanced state machine diagram, Activity diagram		
Unit IV	Architecture Design	08 Hours
Introduction to Architectural design, overview of software architecture, Object oriented software architecture, Client server Architecture, Service oriented Architecture, Component based Architecture, Real time software Architecture		
Unit V	Design patterns	07 Hours

Introduction to Creational design pattern – singleton, Factory ,Structural design pattern- Proxy design pattern, Adapter design pattern, Behavioral – Iterator design pattern, Observer design pattern

Unit VI	Testing	08 Hours
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Introduction to testing, Error, Faults, Failures, verification and validation, Whit Box Testing, Black Box Testing, Unit testing, Integration testing, GUI testing, User acceptance Validation testing, integration testing, scenario testing, performance testing. Test cases and test plan. Case studies expected for developing usability test plans and test cases.

Note: Instructor should frame appropriate case studies/ mini-project (different case study for a group of 6-8 students) on unit-I to unit-V. The case study framed for unit-I may be continued/carry forward for next units if necessary. The same case studies/mini-projects should be tested using appropriate testing tool (preferably open source like Selenium). Draw UML diagrams for mini project.

Books:

Text Books:

1. Jim Arlow, Ila Neustadt, “UML 2 and the unified process –practical object-oriented analysis and design” Addison Wesley, Second edition, ISBN 978-0201770605
2. Hassan Gomaa, “Software Modeling and Design- UML, Use cases, Patterns and Software Architectures” Cambridge University Press, 2011, ISBN 978-0-521-76414-8
3. Srinivasan Desikan, Gopalaswamy Ramesh, “Software testing- Principles and practices” Prentice Hall, 2007, ISBN 9788177581218

References Books:

1. Eric J. Braude, “Software Design: from Programming to Architecture”, J. Wiley, 2004, ISBN 978-0-471-20459-6
2. Gardy Booch, James Rumbaugh, Ivar Jacobson, “The unified modeling language user guide” , Pearson Education, Second edition, 2008, ISBN 0-321-24562-8

Savitribai Phule Pune University Third Year of Computer Engineering (2015 Course) 310254: Web Technology		
Teaching Scheme: TH: 03 Hours/Week	Credit 03	Examination Scheme: In-Sem (Paper): 30 Marks End-Sem (Paper): 70 Marks
Prerequisite Courses: Computer Network (310245) , Database Management Systems (310242)		
Companion Course: Web Technology Lab (310256)		
Course Objectives: <ul style="list-style-type: none"> • To understand the principles and methodologies of web based applications development process • To understand current client side and server side web technologies • To understand current client side and server side frameworks • To understand web services and content management 		
Course Outcomes: On completion of the course, student will be able to– <ul style="list-style-type: none"> • analyze given assignment to select sustainable web development and design methodology • develop web based application using suitable client side and server side web technologies • develop solution to complex problems using appropriate method, technologies, frameworks, web services and content management 		
Course Contents		
Unit I	Web Development Process, Front End Tools	07 Hours
Introduction to web technology, internet and www, Web site planning and design issues, HTML: structure of html document , HTML elements: headings, paragraphs, line break, colors & fonts, links, frames, lists, tables, images and forms, Difference between HTML and HTML5. CSS: Introduction to Style Sheet, Inserting CSS in an HTML page, CSS selectors, XML: Introduction to XML, XML key component, Transforming XML into XSLT, DTD: Schema, elements, attributes, Introduction to JSON.		
Unit II	Client Side Technologies	08 Hours
JavaScript: Overview of JavaScript, using JS in an HTML (Embedded, External), Data types, Control Structures, Arrays, Functions and Scopes, Objects in JS, DOM: DOM levels, DOM Objects and their properties and methods, Manipulating DOM, JQuery: Introduction to JQuery, Loading JQuery, Selecting elements, changing styles, creating elements, appending elements, removing elements, handling events.		
Unit III	Server Side Technologies	08 Hours
Introduction to Server Side technology and TOMCAT, Servlet: Introduction to Servlet, need and advantages, Servlet Lifecycle, Creating and testing of sample Servlet, session management. JSP: Introduction to JSP, advantages of JSP over Servlet , elements of JSP page: directives, comments, scripting elements, actions and templates, JDBC Connectivity with JSP.		
Unit IV	Server Side Technologies	07 Hours
PHP: Introduction to PHP, Features, sample code, PHP script working, PHP syntax, conditions & Loops, Functions, String manipulation, Arrays & Functions, Form handling, Cookies & Sessions, using MySQL with PHP, WAP & WML, AJAX: Introduction, Working of AJAX, AJAX processing steps, coding AJAX script.		

Unit V	Client and Server Side Frameworks	07 Hours
Angular JS : Overview, MVC architecture, directives, expression, controllers, filters, tables, modules, forms, includes, views, scopes, services, dependency injection, custom directives, Internationalization, Introduction to NodeJS. Struts: Overview, architecture, configuration, actions, interceptors, result types, validations, localization, exception handling, annotations.		
Unit VI	Web Services	08 Hours
Web Services: Overview, types of WS, difference between SOAP and REST, EJB: types of EJB, benefits, Architecture, EJB technology, JNDI lookup, Introduction to Content Management System(CMS) ,Wordpress / Joomla, Advanced Technology: Bootstrap, JSF, Spring.		
Books:		
Text: <ol style="list-style-type: none"> 1. Achyut Godbole & Atul Kahate, "Web Technologies: TCP/IP to Internet Application Architectures", McGraw Hill Education publications, ISBN, 007047298X, 9780070472983 2. Ralph Moseley & M. T. Savaliya, "Developing Web Applications", Wiley publications, ISBN 13 : 9788126538676 		
References: <ol style="list-style-type: none"> 1. Adam Bretz & Colin J Ihrig, "Full Stack Javascript Development with MEAN", SPD, ISBN-13: 978-0992461256 2. Giulio Zambon, " Beginning JSP, JSF and Tomcat", Apress Publication, ISBN-10: 1430246235; ISBN-13: 978-1430246237 3. Jeremy McPeak& Paul Wilton," Beginning JavaScript", Wrox Publication, ISBN-13: 978-0470525937 4. Black Book, "Struts 2", Dreamtech Press, ISBN 13, : 9788177228700 5. Black Book, " JDBC 4.2, Servlet 3.1 & JSP 2.3", Dreamtech Press, ISBN-13: 978-8177228700 6. Sandeep Panda, "Angular JS: Novice To Ninja", SPD, First Edition 2014, ISBN-13: 978-0992279455 7. B. V. Kumar, S. Sangeetha, S. V. Subrahmanya,, "J2EE Architecture, an illustrative gateway to enterprise solutions", Tata McGraw Hill Publishing Company. ISBN: 9780070621633 8. Brian Fling, "Mobile Design and Development", O'REILLY, ISBN: 13:978-81-8404-817-9 9. Robin Nixon, "Learning PHP, Mysql and Javascript with JQuery, CSS & HTML5", O'REILLY, ISBN: 13:978-93-5213-015-3 10. Allan Cole, Raeiva Jackson Armitage Brandon R. Jones Jeffrey Way, "Build Your Own Wicked Wordpress Themes", SPD, ISBN: 978-93-5213-154-9 11. Ed Burnette, "Hello , Android Introducing Google' Mobile Development Platform", SPD, ISBN: 13:978-93-5213-085-6 		

Savitribai Phule Pune University Third Year of Computer Engineering (2015 Course) 310255: Seminar and Technical Communication		
Teaching Scheme: TUT: 01 Hour/Week	Credit 01	Examination Scheme: TW: 50 Marks
Course Objectives: <ul style="list-style-type: none"> To explore the basic principles of communication (verbal and non-verbal) and active, empathetic listening, speaking and writing techniques. To expose the student to new technologies, researches, products, algorithms, services 		
Course Outcomes: On completion of the course, student will– <ul style="list-style-type: none"> be able to be familiar with basic technical writing concepts and terms, such as audience analysis, jargon, format, visuals, and presentation. be able to improve skills to read, understand, and interpret material on technology. improve communication and writing skills 		
Guidelines: <ul style="list-style-type: none"> Each student will select a topic in the area of Computer Engineering and Technology preferably keeping track with recent technological trends and development beyond scope of syllabus avoiding repetition in consecutive years. The topic must be selected in consultation with the institute guide. Each student will make a seminar presentation using audio/visual aids for a duration of 20-25 minutes and submit the seminar report prepared in Latex only. Active participation at classmate seminars is essential. BoS has circulated the Seminar Log book and it is recommended to use it. 		
Guidelines for Assessment: Panel of staff members along with a guide would be assessing the seminar work based on these parameters-Topic, Contents and Presentation, regularity, Punctuality and Timely Completion, Question and Answers, Report, Paper presentation/Publication, Attendance and Active Participation.		
Recommended Format of the Seminar Report: <ul style="list-style-type: none"> Title Page with Title of the topic, Name of the candidate with Exam Seat Number / Roll Number, Name of the Guide, Name of the Department, Institution and Year & University Seminar Approval Sheet/Certificate Abstract and Keywords Acknowledgements Table of Contents, List of Figures, List of Tables and Nomenclature Chapters Covering topic of discussion- Introduction with section including organization of the report, Literature Survey/Details of design/technology/Analytical and/or experimental work, if any/,Discussions and Conclusions ,Bibliography/References Plagiarism Check report Report Documentation page 		
References: <ol style="list-style-type: none"> Rebecca Stott, Cordelia Bryan, Tory Young, “Speaking Your Mind: Oral Presentation and Seminar Skills (Speak-Write Series)”, Longman, ISBN-13: 978-0582382435 Johnson-Sheehan, Richard, “Technical Communication”, Longman. ISBN 0-321-11764-6 Vikas Shirodka, “Fundamental skills for building Professionals”, SPD, ISBN 978-93-5213-146-5 		

Savitribai Phule Pune University Third Year of Computer Engineering (2015 Course) 310256: Web Technology Lab		
Teaching Scheme: PR: 02 Hours/Week	Credit 01	Examination Scheme: TW: 25 Marks PR: 50 Marks
Companion Course: Web Technology (310254)		
Course Objectives: <ul style="list-style-type: none"> • To use current client side and server side web technologies • To implement communication among the computing nodes using current client side and server side technologies • To design and implement web services with content management 		
Course Outcomes: On completion of the course, student will be able to– <ul style="list-style-type: none"> • develop web based application using suitable client side and server side web technologies • develop solution to complex problems using appropriate method, technologies, frameworks, web services and content management 		
Guidelines for Instructor's Manual		
The instructor's manual is to be developed as a hands-on resource and reference. The instructor's manual need to include prologue (about University/program/ institute/ department/foreword/preface etc), University syllabus, conduction & Assessment guidelines, topics under consideration-concept, objectives, outcomes, set of typical applications/assignments/ guidelines, and references.		
Guidelines for Student Journal		
The laboratory assignments are to be submitted by student in the form of journal. Journal consists of prologue, Certificate, table of contents, and handwritten write-up of each assignment (Title, Objectives, Problem Statement, Outcomes, software & Hardware requirements, Date of Completion, Assessment grade/marks and assessor's sign, <u>Theory- Concept/technology/tool in brief, design, test cases, conclusion/analysis.</u> 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 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 done based on overall performance and lab assignments performance of student. Each lab assignment assessment will assign grade/marks based on parameters with appropriate weightage. Suggested parameters for overall assessment as well as each lab assignment assessment include- timely completion, performance, innovation, efficient codes, punctuality and neatness.		
Guidelines for Practical Examination		
Both internal and external examiners should jointly set problem statements. <u>During practical assessment, the expert evaluator should give the maximum weightage to the satisfactory implementation of the problem statement.</u> 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. So 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 Laboratory Conduction

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

Suggested List of Laboratory Assignments

1.	<p>Lab Assignment on Unit I: Assignment 1a: Installation and Configuration of Web Application Servers Tomcat, Apache, WebSphere, JBoss, GlassFish. Assignment 1b: Design and develop any suitable web application using HTML, CSS and XML in consultation of course instructor.</p>
2.	<p>Lab Assignment on Unit II: Assignment 2: Perform validation of all fields in assignment no.1 by using Java script/JQuery.</p>
3.	<p>Lab Assignment on Unit III: Assignment 3: Add dynamic web application essence in assignment no. 2 using Servlet, JSP and backend.</p>
4.	<p>Lab Assignment on Unit IV: Assignment 4: Add dynamic web application essence in assignment no. 2 using PHP, MySQL database connectivity and AJAX controls.</p>
5.	<p>Lab Assignment on Unit V: Assignment 5: Re-Design, develop and deploy assignment no. 3 of unit –III using Strut Assignment 6: Re-Design, develop and deploy assignment no. 4 of unit –IV using Angular JS</p>
6.	<p>Lab Assignment on Unit VI: Assignment 6: Design, Develop and Deploy separate web application using EJB/CMS/JSF/Spring/Bootstrap.</p>
7.	<p>Assignment on Software Modeling and Design</p>

Reference Books:

1. Aleksa V and James Goodwill, "Apache Tomcat 7", Apress, 2011, ISBN: 10: 1430237236
2. Bryan Basham, Kathy Sierra, Bert Bates, "JSP: Passing the Sun Certified Web Component Developer Exam", O'Reilly Media ISBN: 978-0-596-51668-0
3. Chirag Rathod, Jonathan Wetherbee, Peter Zadrozny, and Raghu R. Kodali, "Beginning EJB 3: Java EE 7 Edition", Apress, 2013, ISBN : 9781430246923
4. Richard Monson-Haefel, "J2EE Web Services", Addison-Wesley Professional, First Edition, 2004, ISBN: 10: 0321146182
5. Chuck Cavaness, "Programming Jakarta Struts", O'relly Media, second edition 2004, ISBN: 978-0-596-00651-8;
6. Michael Morrison, Lynn Beighley, "Head First PHP & MySQL: A Brain-Friendly Guide", O'relly Media, second edition 2008, ISBN :13: 9788184046588
7. Dan Rahmel, "Advanced Joomla!", Apress, First Edition, 2013, ISBN: 13: 9781430216285
8. Iwein Fuld, Marius Bogoevici, Mark Fisher, Jonas Partner", "Spring Integration in Action", Manning, 2012, ISBN : 13: 9781935182436.

Savitribai Phule Pune University Third Year of Computer Engineering (2015 Course) 310257: System Programming & Operating System Lab		
Teaching Scheme: PR: 04 Hours/Week	Credit 02	Examination Scheme: TW: 25 Marks PR: 50 Marks
Companion Course: Systems Programming and Operating System (310251)		
Course Objectives: <ul style="list-style-type: none"> • To implement basic language translator by using various needed data structures • To implement basic Macroprocessor • To design and implement Dynamic Link Libraries • To implement scheduling schemes 		
Course Outcomes: On completion of the course, student will be able to– <ul style="list-style-type: none"> • Understand the internals of language translators • Handle tools like LEX & YACC. • Understand the Operating System internals and functionalities with implementation point of view 		
Guidelines for Instructor's Manual		
The instructor's manual is to be developed as a hands-on resource and reference. The instructor's manual need to include prologue (about University/program/ institute/ department/foreword/ preface etc), University syllabus, conduction & Assessment guidelines, topics under consideration-concept, objectives, outcomes, set of typical applications/assignments/ guidelines, and references.		
Guidelines for Student Journal		
The laboratory assignments are to be submitted by student in the form of journal. Journal consists of prologue, Certificate, table of contents, and handwritten write-up of each assignment (Title, Objectives, Problem Statement, Outcomes, software & Hardware requirements, Date of Completion, Assessment grade/marks and assessor's sign, <u>Theory- Concept in brief, algorithm, flowchart, Design, test cases, conclusion/analysis.</u> 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 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 done based on overall performance and lab assignments performance of student. Each lab assignment assessment will assign grade/marks based on parameters with appropriate weightage. Suggested parameters for overall assessment as well as each lab assignment assessment include- timely completion, performance, innovation, efficient codes, punctuality and neatness.		
Guidelines for Practical Examination		
Both internal and external examiners should jointly set problem statements. <u>During practical assessment, the expert evaluator should give the maximum weightage to the satisfactory implementation of the problem statement.</u> 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.		
So 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 Laboratory Conduction

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

Set of suggested assignment list is provided in groups- A, B, C, D (All Compulsory)

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

Programming tools recommended: - Eclipse IDE

Books:

1. Paul Gries Jennifer Campbll, Jason Montojo, “Practical Programming Second Edition”, SPD, ISBN: 978-93-5110-469-8

Suggested List of Laboratory Assignments

Group A

1. Design suitable data structures and implement pass-I of a two-pass assembler for pseudo-machine in Java using object oriented feature. Implementation should consist of a few instructions from each category and few assembler directives.
2. Implement Pass-II of two pass assembler for pseudo-machine in Java using object oriented features. The output of assignment-1 (intermediate file and symbol table) should be input for this assignment.
3. Design suitable data structures and implement pass-I of a two-pass macro-processor using OOP features in Java
4. Write a Java program for pass-II of a two-pass macro-processor. The output of assignment-3 (MNT, MDT and file without any macro definitions) should be input for this assignment.

Group B

1. Write a program to create Dynamic Link Library for any mathematical operation and write an application program to test it. (Java Native Interface / Use VB or VC++).
2. Write a program using Lex specifications to implement lexical analysis phase of compiler to generate tokens of subset of ‘Java’ program.
3. Write a program using Lex specifications to implement lexical analysis phase of compiler to count no. of words, lines and characters of given input file.
4. Write a program using YACC specifications to implement syntax analysis phase of compiler to validate type and syntax of variable declaration in Java.
5. Write a program using YACC specifications to implement syntax analysis phase of compiler to recognize simple and compound sentences given in input file.

Group C

1. Write a Java program (using OOP features) to implement following scheduling algorithms: FCFS , SJF (Preemptive), Priority (Non-Preemptive) and Round Robin (Preemptive)
2. Write a Java program to implement Banker’s Algorithm
3. Implement UNIX system calls like ps, fork, join, exec family, and wait for process management (use shell script/ Java/ C programming).
4. Study assignment on process scheduling algorithms in Android and Tizen.

Group D

- Write a Java Program (using OOP features) to implement paging simulation using
1. Least Recently Used (LRU)
 2. Optimal algorithm

Savitribai Phule Pune University Third Year of Computer Engineering (2015 Course) 310258: Embedded Systems & Internet of Things Lab		
Teaching Scheme: PR: 02 Hours/Week	Credit 01	Examination Scheme: TW: 50 Marks
Companion Course –Embedded Systems & Internet of Things (310252)		
Course Objectives: <ul style="list-style-type: none"> • To understand functionalities of various single board embedded platforms fundamentals • To develop comprehensive approach towards building small low cost embedded IoT system. • To understand different sensory inputs. 		
Course Outcomes: On completion of the course, student will be able to– <ul style="list-style-type: none"> • Design the minimum system for sensor based application • Solve the problems related to the primitive needs using IoT • Develop full fledged IoT application for distributed environment 		
Guidelines for Instructor's Manual		
The instructor's manual is to be developed as a hands-on resource and reference. The instructor's manual need to include prologue (about University/program/ institute/ department/foreword/ preface etc), University syllabus, conduction & Assessment guidelines, topics under consideration-concept, objectives, outcomes, set of typical applications/assignments/ guidelines, and references.		
Guidelines for Student Journal		
The laboratory assignments are to be submitted by student in the form of journal. Journal consists of prologue, Certificate, table of contents, and <u>handwritten write-up</u> of each assignment (Title, Objectives, Problem Statement, Outcomes, software & Hardware requirements, Date of Completion, Assessment grade/marks and assessor's sign, <u>Theory- Concept in brief, algorithm, flowchart, test cases, conclusion/analysis.</u> <u>Program codes with sample output of all performed assignments are to be submitted as softcopy.</u>		
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 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.		
Guidelines for Practical Examination		
Both internal and external examiners should jointly set problem statements. <u>During practical assessment, the expert evaluator should give the maximum weightage to the satisfactory implementation of the problem statement.</u> 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. So 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 Laboratory Conduction

The instructor is expected to frame the assignments by understanding the prerequisites, technological aspects, utility and recent trends related to the topic. The assignment framing policy need to address the average students and inclusive of an element to attract and promote the intelligent students. The instructor may set multiple sets of assignments and distribute among batches of students. It is appreciated if the assignments are based on real world problems/applications.

In addition to these, instructor may assign one real life application in the form of a mini-project based on the concepts learned. Instructor may also set one assignment or mini-project that is suitable to respective branch beyond the scope of syllabus.

Set of suggested assignment list is provided in groups- A, B, C, D, and E. Each student must perform at least 11 assignments as at least 3 from group A, 3 from group B, 2 from group C, 2 from group D and 1 from group E. **UML diagrams are to be drawn for group E assignment.**

References:

1. Nitesh Dhanjani, "Abusing the Internet of Things", O'REILLY, ISBN: 13:978-93-5313-217-1
2. Cuno Pfister, "Getting Started with the Internet of Things", O'REILLY, ISBN: 13:978-93-53023-413-6
3. Massimo Banzi and Michael Shiloh, "Getting Started with Arduino", MAKER MEDIA, ISBN: 13:978-93-5110-907-5
4. Don Wilcher, "BASIC Arduino Projects", MAKER MEDIA, ISBN: 13:978-93-5110-503-9
5. Cefn Hoile, Clare Bowman, Sjoerd Dirk Meijer, Brian Corteil, Lauren Orsini, "Raspberry Pi and AVR Projects", MAKER MEDIA, ISBN: 13:978-93-5110-914-3
6. Wolfrom Donot, "A Raspberry Pi Controlled Robot", MAKER MEDIA, ISBN: 13:978-93-5110-913-6
7. Kimmo Karvinen and Tero Karvinen, "Arduino Bots and Gadgets", O'REILLY, ISBN: 13:978-93-5023-374-0
8. Derek Molley, "Exploring Beaglebone", Willey, ISBN: 978-1-118-935125
9. Matt Richardson and Shawn Wallace, "Getting with Raspberry Pi", MAKER MEDIA, ISBN: 978-93-5213-450-2
10. Dr. Simon Monk, "Raspberry PiCook-Book", O'REILLY, ISBN: 978-93-5213-389-5

Suggested List of Laboratory Assignments

Group A

- | | |
|----|--|
| 1. | Study of Raspberry-Pi, Beagle board, Arduino and other micro controller (History & Elevation) |
| 2. | Study of different operating systems for Raspberry-Pi /Beagle board. Understanding the process of OS installation on Raspberry-Pi /Beagle board |
| 3. | Study of Connectivity and configuration of Raspberry-Pi /Beagle board circuit with basic peripherals, LEDS. Understanding GPIO and its use in program. |
| 4. | Understanding the connectivity of Raspberry-Pi /Beagle board circuit with temperature sensor. Write an application to read the environment temperature. If temperature crosses a threshold value, the application indicated user using LEDSs |

Group B

- | | |
|----|--|
| 5. | Understanding the connectivity of Raspberry-Pi /Beagle board circuit with IR sensor. Write an application to detect obstacle and notify user using LEDs. |
| 6. | Understanding and connectivity of Raspberry-Pi /Beagle board with camera. Write an application to capture and store the image. |
| 7. | Understanding and connectivity of Raspberry-Pi /Beagle board with a Zigbee module. Write a network application for communication between two devices using Zigbee. |
| 8. | Study of different CPU frequency governors. Write an application to change CPU frequency of Raspberry-Pi /Beagle board |

Group C	
9.	Write an application using Raspberry-Pi /Beagle board to control the operation of stepper motor.
10.	Write an application using Raspberry-Pi /Beagle board to control the operation of a hardware simulated traffic signal.
11.	Write an application using Raspberry-Pi /Beagle board to control the operation of a hardware simulated lift elevator
Group D	
12.	Write a server application to be deployed on Raspberry-Pi /Beagle board. Write client applications to get services from the server application.
13.	Create a small dashboard application to be deployed on cloud. Different publisher devices can publish their information and interested application can subscribe.
14.	Create a simple web interface for Raspberry-Pi/Beagle board to control the connected LEDs remotely through the interface.
Group E	
15.	Develop a Real time application like smart home with following requirements: When user enters into house the required appliances like fan, light should be switched ON. Appliances should also get controlled remotely by a suitable web interface. The objective of this application is student should construct complete Smart application in group.
16.	Develop a Real time application like a smart home with following requirements: If anyone comes at door the camera module automatically captures his image send it to the email account of user or send notification to the user. Door will open only after user's approval.

Savitribai Phule Pune University
Third Year of Computer Engineering (2015 Course)
310259: Audit Course 4

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 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 as 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/revise-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)

- | | |
|---|--|
| <ul style="list-style-type: none"> • Lectures/ Guest Lectures • Visits (Social/Field) and reports • Demonstrations | <ul style="list-style-type: none"> • Surveys • Mini Project • Hands on experience on specific focused topic |
|---|--|

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

- | | |
|---|---|
| <ul style="list-style-type: none"> • Written Test • Demonstrations/ Practical Test • Presentations | <ul style="list-style-type: none"> • IPR/Publication • Report |
|---|---|

Audit Course 3 Options

AC4- I	Digital and Social Media Marketing
AC4-II	Green Computing
AC4-III	Sustainable Energy Systems
AC4-IV	Leadership and Personality Development
AC4-V	Foreign Language (one of Japanese/ Spanish/French/German). Course contents for Japanese (Module 4) are provided. For other languages institute may design suitably.

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
Third Year of Computer Engineering (2015 Course)
310259: Audit Course 4
AC4 – I: Digital & Social Media Marketing

The importance of social media's role in modern marketing efforts can no longer be ignored. It's an integral component in almost all successful marketing strategies. With this increasing emphasis on integrated social media strategies, there is an Irrefutable need for marketing professionals and organizations to have end- to- end social media expertise. Through case studies, interactive sessions, and class exercises, students will learn best practices and develop the skills to connect business objectives with social media strategy, platforms and tactics. Topics will include choosing appropriate platforms, creating effective and engaging social media content, content management, social listening and creating a social media policy

Course Objectives:

- Identify best practices for Social Media Marketing, including platform level best practices.
- Connect business objectives to appropriate Social Media tactics.
- Create strong content that engages their target audience with their marketing message.

Course Outcome:

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

- Create editorial calendars to manage content distribution.
- Use Social Listening tools to create timely, relevant content.
- Create Social Media policies that combine business objectives with appropriate use of social media channels and content.

Course Contents:

1. Introductions and review class objectives, Discuss class goals and individual goals, Fill out questionnaire, Introduction to Blogging, Create a blog post for your project. Include headline, imagery, links and post.
2. Introduction to Facebook and channel advertising and campaigns, Introduction to Twitter and channel advertising and campaigns, Creative Campaign examples across social channels
3. Introduction to both Google+ and LinkedIn. Provide an overview on LinkedIn advertising, Create Google+ and LinkedIn outlines for your project and include: types of posts and an example post for each platform.
4. Introduction to both Instagram and Pinterest as well as channel advertising and campaigns, Create Instagram and Pinterest outlines for your project and include: types of posts and an example post for each platform, review a content calendar, Lay out your own content calendar.

References:

1. Vandana Ahuja, Digital Marketing, Oxford Press, ISBN: 9780199455447,
2. Wiley, Jeanniey Mullen, David Daniels, David Gilmour “ Email Marketing: An Hour a Day”, ISBN: 978-0-470-38673-6
3. David Scott, “The New Rules of Marketing and PR”, Wiley India, ISBN: 978-1-119-07048-1

Savitribai Phule Pune University, Pune
Third Year of Computer Engineering (2015 Course)
310259: Audit Course 4
AC4 – II: Green Computing

Green computing is the study and practice of using computing resources efficiently. Green computing or green IT, refers to environmentally sustainable computing or IT. The goals of green computing are similar to green chemistry; reduce the use of hazardous materials, Maximize energy efficiency during the product's lifetime, and promote the recyclability or biodegradability of defunct products and factory waste.

Course Objectives:

- To acquire knowledge to adopt green computing practices to minimize negative impacts on the environment.
- To examine technology tools that can reduce paper waste and carbon footprint by user.
- To understand how to minimize equipment disposal requirements.
- To gain skill in energy saving practices in their use of hardware

Course Outcome:

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

- Understand the concept of green IT and relate it to sustainable development.
- Apply the green computing practices to save energy.
- Discuss how the choice of hardware and software can facilitate a more sustainable operation,
- Use methods and tools to measure energy consumption

Course Contents:

- 1. Fundamentals of Green IT:** Green IT Fundamentals: Business, IT, and the Environment – Green computing: carbon foot Print - Measuring, Details, reasons to bother, Plan for the Future, Cost Savings: Hardware, Power.
- 2. Green Assets and Power Problems:** Green Assets: Buildings, Data Centers, Networks, and Devices, Green Information Systems : Design and Development Models, Monitoring Power Usage, Servers, Low-Cost Options, Reducing Power Use, Data De-Duplication, Low-Power Computers and peripheral devices
- 3. Greening Information Systems:** Initial Improvement Calculations, Selecting Metrics, Tracking Progress, Change Business Processes, Customer Interaction, Paper Reduction, Green Supply Chain, Improve Technology Infrastructure, Reduce PCs and Servers, Shared Services, Hardware Costs, Cooling
- 4. Green Grid Framework:** Virtualizing of IT systems – Role of electric utilities, Telecommuting, teleconferencing and teleporting – Materials recycling – Best ways for Green PC – Green Data center Case Studies – Applying Green IT Strategies and Applications to a Home Hospital, Packaging Industry and Telecom Sector

References:

1. Woody Leonhard, Katherrine Murray, “Green Home computing for dummies”, August 2009, ISBN: 978-0-470-46745-9
2. Alvin Galea, Michael Schaefer, Mike Ebbers, “Green Data Center: steps for the Journey”, Shoff/IBM rebook, 2011. ISBN: 10: 1-933742-05-4; 13: 978-1-933742-05-2
3. John Lamb, “The Greening of IT”, Pearson Education, 2009, ISBN 10: 0137150830
4. Jason Harris, “Green Computing and Green IT- Best Practices on regulations & industry”, Lulu.com, 2008, ISBN: 1558604898
5. Bud E. Smith, “Green Computing Tools and Techniques for Saving Energy, Money and Resources”, CRC Press, 2014, 9781466503403

Savitribai Phule Pune University, Pune
Third Year of Computer Engineering (2015 Course)
310259: Audit Course 4
AC4 – III: Sustainable Energy Systems

Course Objectives:

- To understand the impact of engineering solutions on a global, economic, environmental, and societal context.
- To design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

Course Outcome:

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

- Demonstrate an overview of the main sources of renewable energy.
- Understand benefits of renewable and sustainable energy systems.

Course Contents:

1. Introduction and Energy Fundamentals, Sustainable Energy Systems: Issues for the 21st century, the critical challenges for a sustainable energy future, Sustainable energy systems: definitions, indicators, Physics of Energy: Laws of Thermodynamics Energy Forms and Conversion, First and Second Laws and Efficiencies Devices: Heat Engines, Refrigerators and Heat Pumps Instantaneous and Average Power.
2. Introduction to Renewable Energy, Wind Energy Wind Turbine Technologies Wind Resources and Modeling Energy Performance and Environmental Impacts Economics and Economic Development Impacts, Photovoltaic: PV and BIPV Technologies Solar Resources and Modeling Energy Performance and Environmental Impacts, Economics and Net Metering
3. Biomass: Electricity Biomass Technologies Introduction Biomass Productivity and Modeling Biopower: MSW, willows/switch grass/ poplar, wood waste, Biomass: Transport Fuels Biofuels, Bioethanol, Biodiesel, Algal, Jatropha Biofuels and Water Land Use Impacts, Food vs Fuel, Renewable Fuels Standards
4. Building Energy Technologies and Policy, Smart buildings, Lighting and LEDs, Heating/cooling, technologies.

References:

1. İbrahim Dinçer, Calin Zamfirescu, “Sustainable Energy Systems and Applications”, Springer; 2012 edition, ISBN-10: 0387958606
2. D. Mukherjee, “Fundamentals of Renewable Energy Systems”, Atlantic, ISBN: 10: 8122415407
3. John R. Barker and Marc H. Ross Am. J. Phys, “An introduction to global warming”, ISBN: 0-632-03779-2

Savitribai Phule Pune University, Pune
Third Year of Computer Engineering (2015 Course)
310259: Audit Course 4
AC4 – IV: Leadership and Personality Development

Personality is considered as one of the integral part of an individual's existence. Where a student is concerned, paying close attention to **Personality** which is extremely important to enhance holistic development of students and improve their employability skills

Course Objectives:

- To develop inter personal skills and be an effective goal oriented team player.
- To develop professionals with idealistic, practical and moral values.
- To develop communication and problem solving skills.
- To re-engineer attitude and understand its influence on behavior

Course Outcome:

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

- Enhance holistic development of students and improve employability skills

Course Contents:

- 1. Introduction to Personality and working towards developing it:** Definition & Basics of personality, Analyzing strengths & weaknesses, Corporate theories on personality Development, Increasing Vocabulary, Body Language, gestures, Preparation of Self Introduction
- 2. Communication skill and handling attitude:** Communication Skills, Listening, Communication Barriers, Overcoming these Barriers, Building Self Esteem and Self Confidence, Working on attitudes: aggressive, assertive, and submissive
- 3. Leadership Techniques in Personality development:** Introduction to Leadership, Leadership Styles, Group Dynamics, Team Building
- 4. Stress and time management skills:** Interpersonal Relationships, Analysis of Ego States, transactions & Life positions, Stress Management: Causes, Impact & Managing Stress, Introduction to conflict management, Time Management: Concept of time management, Steps towards better time management

References:

1. SOFT SKILLS, “ Career Development Centre”, Green Pearl Publications
2. Covey Sean,” Seven Habits of Highly Effective Teens”, New York, Fireside Publishers, 1998, ISBN: 978-1476764665
3. Carnegie Dale, “ How to win Friends and Influence People”, New York: Simon & Schuster, 1998, ISBN: 1-4391-6734-6
4. Thomas A Harris, I am ok, You are ok , New YorkHarper and Row, 1972, ISBN 13: 978-0060724276ISBN:
5. Daniel Coleman, Emotional Intelligence, Bantam Book, 2006, ISBN: 055380491X, 9780553804911
6. Shiv Khera, “You Can Win”, A&C Black, ISBN: 9780230331198.

Savitribai Phule Pune University, Pune
Third Year of Computer Engineering (2015 Course)
310259: Audit Course 4
AC4 – V: Foreign Language(Japanese Module 4)

Prerequisite Courses: Audit Course AC1-V(210250), AC2-V(210258), AC3-V(310249)

About Course:

With changing times, the competitiveness has gotten into the nerves and Being the Best' at all times is only the proof of it. Nonetheless, being the best differs significantly from Communicating the best. The best can merely be communicated whilst using the best suitable Language!

Foreign languages like Japanese is the new trend of 21st century. Not only youngsters but even the professionals seek value in it. It is the engineer's companion in current times with an assertion of a thriving future. Metro cities like Pune has indisputably grown to become a major center of Japanese Education in India while increasing the precedence for Japanese connoisseurs.

Japanese certainly serves a great platform to unlock a notoriously tough market & find a booming career. While the companies prefer candidates having the knowledge of the language, it can additionally help connect better with the native people thus prospering in their professional journey. Learning Japanese gives an extra edge to the resume since the recruiters consciously make note of the fact it requires real perseverance and self-discipline to tackle one of the most complex languages.

It would be easy for all time to quit the impossible; however it takes immense courage to reiterate the desired outcomes, recognize that improvement is an ongoing process and ultimately soldier on it. The need of an hour is to introduce Japanese language with utmost professionalism to create awareness about the bright prospects and to enhance the proficiency and commitment. It will then prove to be the ultimate path to the quest for professional excellence!

Course Objectives:

- To meet the needs of ever growing industry with respect to language support.
- To get introduced to Japanese society and culture through language.

Course Outcome:

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

- Possess ability of basic communication.
- Possess the knowledge of Japanese script.
- Get introduced to reading, writing and listening skills for language Japanese.
- Develop interest to pursue professional Japanese Language course

Course Contents:

1. Stating existence or a presence of thing (s), person (s), Relative positions, Counters
2. Expressing one's Desire & wants, Verb groups, Asking, Instructing a person to do something
3. Indicating an action or motion is in progress, Describing habitual action, describing a certain continuing state which resulted from a certain action in the past. Express permission & prohibition

References:

1. Minna No Nihongo, "Japanese for Everyone", Elementary Main Text book 1-1 (Indian Edition), Goyal Publishers & Distributors Pvt. Ltd.
2. <http://www.tcs.com> (http://www.tcs.com/news_events/press_releases/Pages/TCS-Inaugurates-Japan-centric-Delivery-Center-Pune.aspx)

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

First Year 50 Credit	Second Year 50 Credit	Third Year 46 Credit	Fourth Year (Proposed) 44 Credit
Semester I			
FPL I	Discrete Mathematics	Theory of Computation	Parallel Architectures and Concurrent Computing
Engineering Maths I	Digital Electronics and Logic Design	Database Management Systems (DBMS)	Data Analytics
Engineering Physics	Data Structures and Algorithms	Software Engineering & Project Management	Software Testing & Quality Assurance
Basic Electrical Engineering	Computer Organization and Architecture	Information Systems & Engineering Economics	Elective I – <ul style="list-style-type: none"> • Digital Signal Processing • Advanced Databases, • Artificial Intelligence, • Wireless Sensor Networks
Engineering Graphics I	Object Oriented Programming(OOP)	Computer Networks (CN)	Elective II- <ul style="list-style-type: none"> • Cloud Computing, • Soft Computing • Software Architecture & Design • Operation Research
Basic Civil and Environmental Engineering	OOP Lab	Skill Development Lab	Lab I
Workshop Practice	Digital Electronics Lab	DBMS Lab	Lab II
Engineering Physics Lab	Data Structures Lab	CN Lab	Project Stage I
---	Soft Skills Lab	Audit Course 3	Audit Course 5
---	Audit Course 1	-----	-----
Semester II			
FPL II	Engineering Mathematics III	Design & Analysis of Algorithms	Distributed Systems
Engineering Maths II	Computer Graphics	Systems Programming & Operating System (SP& OS)	Information Security
Engineering Chemistry	Advanced Data Structures	Embedded Systems & Internet of Things (ES & IoT)	Elective-III : <ul style="list-style-type: none"> • Data Mining & Data Warehouse • Mobile Communication, • Image Processing • Human Computer Interface
Basic Electronics Engineering	Microprocessor	Software Modeling and Design	Elective-IV : <ul style="list-style-type: none"> • Principles of Compiler Design • Embedded & Real Time OS, • Pervasive and Ubiquitous Computing • Open Elective
Basic Mechanical Engineering	Principles of Programming Languages	Web Technology (WT)	Lab III
Engineering Mechanics	Computer Graphics Lab	Seminar & Technical Communication	Lab IV
Engg Graphics II	Advanced Data Structures Lab	Web Technology Lab	Project Work
Engg Chemistry Lab	Microprocessor Lab	ES & IoT Lab	Audit Course 6
----	Audit Course 2	SP & OS Lab	-----
----	-----	Audit Course 4	-----

Savitribai Phule Pune University
Computer Engineering (2015 Course)

Courses-Credit Share

Sr. No	Category	Comprised of (Total Credit)	% of Credit Share
1	Foundational Courses (47 Credit)	<ul style="list-style-type: none"> Mathematics (18) Engineering Sciences (10) Fundamentals of Core Engineering Domain (19) 	25%
2	Program Specific Courses (Theory) (90 Credit)	Core (40)	47%
		Advanced (38)	
		Elective + Open Elective (12)	
3	Add on Courses (Audit +Credit Courses) (05 Credit)	<ul style="list-style-type: none"> Social Awareness Environmental Personal Development Economics (04) Soft Skills (01) 	3%
4	Skills Development Courses (48 Credit)	<ul style="list-style-type: none"> Project (major) (08) Seminar (01) Labs + Mini-Project (39) 	25%

Courses Credit Share

