



**RAMNIRANJAN JHUNJHUNWALA COLLEGE
OF ARTS, SCIENCE AND COMMERCE,
GHATKOPAR(W), MUMBAI**

(AFFILIATED TO MUMBAI UNIVERSITY)



**SYLLABUS FOR: T. Y. BSc
PROGRAM: B.Sc.
COURSE: COMPUTER SCIENCE**

WITH EFFECT FROM ACADEMIC YEAR 2019-20

Date: _____

Signature of BOS Members

1) Chairman :Anita Gaikwad

2) Subject Experts from outside the Parent University:

i) Prof Suchita Bhovar,
SNDT College, Ghatkopar

i) Prof Pratibha Deshmukh,
Bharathi Vidyapeeth, Navi Mumbai

3) Expert to be nominated by Vice Chancellor:

Prof Sampada Margaj, Kirti College Dadar

4) Representative from industry:

Mr Uday Pawar, Director Tech, People Interactive Pvt Ltd

5) Post graduate alumni:

Prof Sunita Rai, Khalasa College, Matunga

6) Experts from outside the college:

- i) Prof Geeta Brijwani, K C College, Churchgate
- ii) Prof Maya Nair, SIES College, Sion
- iii) Prof Poonam Pandey, Somaiya College, Vidyavihar

Preamble

This is the third year curriculum in the subject of Computer Science. The revised structure is designed to transform students into technically competent, socially responsible and ethical Computer Science professionals. In these Semesters we have made the advancements in the subject based on the previous Semesters Knowledge.

In the first year basic foundation of important skills required for software development is laid. Second year of this course is about studying core computer science subjects. The third year is the further advancement which covers developing capabilities to design formulations of computing models and its applications in diverse areas.

The proposed curriculum contains two semesters, each Semester contains two Electives: Elective-I and II. Every Elective contains three papers based on specific areas of Computer Science. It also includes one Skill Enhancement paper per semester, helps the student to evaluate his/her computer science domain specific skills and also to meet industry expectations. This revised curriculum has not only taken the specific areas of computer science into consideration but will also give the opportunity to the student to prove his/her ability in the subject practically through the Project Implementation. In Semester V and Semester VI student has to undertake a Project. It can boost his/her confidence and also can encourage the student to perform innovations in the subject as the choice of the Project topic is kept open covering most of the areas of Computer Science subject as per the students interest and the subject they have learned during the Course.

Proposed Curriculum contains challenging and varied subjects aligned with the current trend with the introduction of Machine Intelligence specific subject such as Artificial Intelligence, Information Retrieval. Data Management related subjects such as Cloud Computing and Data Science. Image processing topics such as Game Programming, Digital Image Processing. Introduction of physical world through Architecting of IoT and Wireless Sensor Networks and Mobile Communication. Security domain is also evolved by the introduction of Ethical Hacking, Cyber Forensic and Information and Network Security. To get the hands on experience Linux Server Administration and Web Services topics are included.

In essence, the objective of this syllabus is to create a pool of technologically savvy, theoretically strong, innovatively skilled and ethically responsible generation of computer science professionals. Hope that the teacher and student community of University of Mumbai will accept and appreciate the efforts.

T.Y.B. Sc. (Semester V and VI)
Computer Science Syllabus
Credit Based Semester and Grading System
To be implemented from the Academic year 2018-2019
SEMESTER V

Course	TOPICS	Credits	L / Week
RJSCSS501	Artificial Intelligence	3	3
RJSCSS502	Linux Server Administration	3	3
RJSCSS503	Information and Network Security	3	3
RJSCSS504	Web Services	3	3
Skill Enhancement			
RJSCSS505	Software Testing and Quality Assurance	2	3
Practical			
RJSCSS5P01	Practical of Group-I (AI & Linux)	2	6
RJSCSS5P02	Practical of Group-II (Security & Web Services)	2	6
RJSCSS5P03	Project Implementation	1	3
RJSCSS5P04	Practical of Skill Enhancement : RJSCSS505	1	3
SEMESTER VI			
Course	TOPICS	Credits	L / Week
RJSCSS601	Wireless Sensor Networks and Mobile Communication	3	3
RJSCSS602	Cloud Computing	3	3
RJSCSS603	Advanced Database Systems	3	3
RJSCSS604	Data Science	3	3
Skill Enhancement			
RJSCSS605	Ethical Hacking	2	3
Practical			
RJSCSS6P01	Practical of Group – I (WSN & Cloud Computing)	2	6
RJSCSS6P02	Practical of Group – II (Advanced Database Systems & Data Science)	2	6
RJSCSS6P03	Project Implementation	1	3
RJSCSS6P04	Practical of Skill Enhancement : RJSCSS605	1	3

SEMESTER V

THEORY

Course: RJSCSS501	TOPICS (Credits : 03 Lectures/Week:03) Artificial Intelligence	
Objectives: Artificial Intelligence (AI) and accompanying tools and techniques bring transformational changes in the world. Machines capability to match, and sometimes even surpass human capability, make AI a hot topic in Computer Science. This course aims to introduce the learner to this interesting area.		
Expected Learning Outcomes: After completion of this course, learner should get a clear understanding of AI and different search algorithms used for solving problems. The learner should also get acquainted with different learning algorithms and models used in machine learning.		
Unit I	What Is AI: Foundations, History and State of the Art of AI. Intelligent Agents: Agents and Environments, Nature of Environments, Structure of Agents. Problem Solving by searching: Problem-Solving Agents, Example Problems, Searching for Solutions, Uninformed Search Strategies, Informed (Heuristic) Search Strategies, Heuristic Functions.	15L
Unit II	Learning from Examples: Forms of Learning, Supervised Learning, Learning Decision Trees, Evaluating and Choosing the Best Hypothesis, Theory of Learning, Regression and Classification with Linear Models, Artificial Neural Networks, Nonparametric Models, Support Vector Machines, Ensemble Learning of Practical Machine Learning, Genetic Algorithm: random selection, crossover, mutation.	15L
Unit III	Learning probabilistic models: Reinforcement learning: Passive Reinforcement Learning, Active Reinforcement Learning, Generalization in Reinforcement Learning, Applications of Reinforcement Learning. Robotics: Difference between robotics and AI, Robot locomotion, computer vision, task of computer vision, application of computer vision and robotics, Bayesian network, Natural language processing: components of NLP, steps in NLP, Expert System: components of expert system, Knowledge base: components of knowledge base.	15L
Textbook(s): Artificial Intelligence: A Modern Approach, Stuart Russell and Peter Norvig,3rd Edition, Pearson, 2010.		
Additional Reference(s): 1) Artificial Intelligence: Foundations of Computational Agents, David L Poole,Alan K. Mackworth, 2nd Edition, Cambridge University Press ,2017. 2) Artificial Intelligence, Kevin Knight and Elaine Rich, 3rd Edition, 2017		

- 3) The Elements of Statistical Learning, Trevor Hastie, Robert Tibshirani and Jerome Friedman, Springer, 2013

Course: RJSCSS502		TOPICS (Credits : 03 Lectures/Week:03) Linux System Administration	
Objectives: Demonstrate proficiency with the Linux command line interface, directory & file management techniques, file system organization, and tools commonly found on most Linux distributions. Effectively operate a Linux system inside of a network environment to integrate with existing service solutions. Demonstrate the ability to troubleshoot challenging technical problems typically encountered when operating and administering Linux systems.			
Expected Learning Outcomes: Learner will be able to develop Linux based systems and maintain. Learner will be able to install appropriate service on Linux server as per requirement. Learner will have proficiency in Linux server administration.			
Unit I	Introduction: Technical Summary of Linux Distributions, Managing Software Single-Host Administration: Managing Users and Groups, Booting and shutting down processes, File Systems, Core System Services, Process of configuring, compiling, Linux Kernel Networking and Security: TCP/IP for System Administrators, basic network Configuration, Linux Firewall		15L
Unit II	Internet Services: Domain Name System (DNS), File Transfer Protocol (FTP), Apache web server, Simple Mail Transfer Protocol (SMTP), Post Office Protocol and Internet Mail Access Protocol (POP and IMAP), Secure Shell (SSH), Network Authentication, OpenLDAP Server, Samba and LDAP, Network authentication system (Kerberos), Domain Name Service (DNS), Security		15L
Unit III	Network File System (NFS), Samba, Distributed File Systems (DFS), Network Information Service (NIS), Lightweight Directory Access Protocol (LDAP), Dynamic Host Configuration Protocol (DHCP), MySQL, LAMP Applications File Servers, Email Services, Chat Applications, Virtual Private Networking.		15L
Textbook(s): 1) Linux Administration: A Beginner’s Guide, Wale Soyinka, Seventh Edition, McGraw-Hill Education, 2016 2) Ubuntu Server Guide, Ubuntu Documentation Team, 2016			

Additional Reference(s): Mastering Ubuntu Server, Jay LaCroix, PACKT Publisher, 2016		
Course: RJSCSS503	TOPICS (Credits : 03 Lectures/Week:03) Information and Network Security	
Objectives: To provide students with knowledge of basic concepts of computer security including network security and cryptography.		
Expected Learning Outcomes: Understand the principles and practices of cryptographic techniques. Understand a variety of generic security threats and vulnerabilities, and identify & analyze particular security problems for a given application. Understand various protocols for network security to protect against the threats in a network		
Unit I	Introduction: Security Trends, The OSI Security Architecture, Security Attacks, Security Services, Security Mechanisms Classical Encryption Techniques: Symmetric Cipher Model, Substitution Techniques, Transposition Techniques, Steganography, Block Cipher Principles, The Data Encryption Standard, The Strength of DES, AES (round details not expected), Multiple Encryption and Triple DES, Block Cipher Modes of Operation, Stream Ciphers Public-Key Cryptography and RSA: Principles of Public-Key Cryptosystems, The RSA Algorithm	15L
Unit II	Key Management: Public-Key Cryptosystems, Key Management, Diffie-Hellman Key Exchange Message Authentication and Hash Functions: Authentication Requirements, Authentication Functions, Message Authentication Codes, Hash Functions, Security of Hash Functions and Macs, Secure Hash Algorithm, HMAC Digital Signatures and Authentication: Digital Signatures, Authentication Protocols, Digital Signature Standard Authentication Applications: Kerberos, X.509 Authentication, Public-Key Infrastructure	15 L
Unit III	Electronic Mail Security: Pretty Good Privacy, S/MIME IP Security: Overview, Architecture, Authentication Header, Encapsulating Security Payload, Combining Security Associations, Key Management Web Security: Web Security Considerations, Secure Socket Layer and Transport Layer Security, Secure Electronic Transaction Intrusion: Intruders, Intrusion Techniques, Intrusion Detection Malicious Software: Viruses and Related Threats, Virus Countermeasures, DDOS Firewalls: Firewall Design Principles, Types of Firewalls	15L
Textbook(s): 1) Cryptography and Network Security: Principles and Practice 5th Edition, William Stallings.		

Pearson,2010

Additional Reference(s):

1) Cryptography and Network Security, Atul Kahate, Tata McGraw-Hill, 2013.2) Cryptography and Network, Behrouz A Fourouzan, Debdeep Mukhopadhyay, 2nd Edition, TMH, 2011

Course: RJSCSS504	TOPICS (Credits : 03 Lectures/Week:03) Web Services
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Objectives:

To understand the details of web services technologies like SOAP, WSDL, and UDDI. To learn how to implement and deploy web service client and server. To understand the design principles and application of SOAP and REST based web services (JAX-WS and JAX-RS). To understand WCF service. To design secure web services and QoS of Web Services

Expected Learning Outcomes:

Emphasis on SOAP based web services and associated standards such as WSDL. Design SOAP based / RESTful / WCF services Deal with Security and QoS issues of Web Services.

Unit I	What Are Web Services? Types of Web Services , overview of XML, SOAP, Building Web Services with JAX-WS, Registering and Discovering Web Services, Service Oriented Architecture, Web Services Development Life Cycle, Developing and consuming simple Web Services across platform. Developing Service-Oriented Applications with WCF.	15L
Unit II	Introducing HTTP,HTTPS, The core architectural elements of a RESTful system, Description and discovery of RESTful web services, Java tools and frameworks for building RESTful web services, JSON message format and tools and frameworks around JSON, Build RESTful web services with JAX-RS APIs, The Description and Discovery of RESTful Web Services, Design guidelines for building RESTful web services, Secure RESTful web services.	15L
Unit III	Microservices: The Concept of Going Micro, Advantages & Disadvantages, Microservice Over SOA, Microservice Scaling, Different Elements of Microservices, Composition Patterns, Examples.	15L

Textbook(s):

- 1) Web Services: Principles and Technology, Michael P. Papazoglou, Pearson Education Limited, 2008
- 2) RESTful Java Web Services, Jobinesh Purushothaman, PACKT Publishing, 2nd Edition, 2015
- 3) Developing Service-Oriented Applications with WCF, Microsoft, 2017
<https://docs.microsoft.com/en-us/dotnet/framework/wcf/index>

Additional Reference(s):

- 1) Leonard Richardson and Sam Ruby, RESTful Web Services, O'Reilly, 2007
- 2) The Java EE 6 Tutorial, Oracle, 2013

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Course: RJSCSS505	TOPICS (Credits : 03 Lectures/Week:03) Skill Enhancement: Software Testing and Quality Assurance
Objectives: To provide learner with knowledge in Software Testing techniques. To understand how testing methods can be used as an effective tools in providing quality assurance concerning for software. To provide skills to design test case plan for testing software Expected Learning Outcomes: Understand various software testing methods and strategies. Understand a variety of software metrics, and identify defects and managing those defects for improvement in quality for given software. Design SQA activities, SQA strategy, formal technical review report for software quality control and assurance.	
Unit-I	Software Testing and Introduction to quality : Introduction, Nature of errors, an example for Testing, Definition of Quality , QA, QC, QM and SQA , Software Development Life Cycle, Software Quality Factors Verification and Validation : Definition of V &V , Different types of V & V Mechanisms, Concepts of Software Reviews, Inspection and Walkthrough Software Testing Techniques : Testing Fundamentals, Test Case Design, White Box Testing and its types, Black Box Testing and its types
Unit II	Software Testing Strategies : Strategic Approach to Software Testing, Unit Testing, Integration Testing, Validation Testing, System Testing Software Metrics : Concept and Developing Metrics, Different types of Metrics, Complexity metrics Defect Management: Definition of Defects, Defect Management Process, Defect Reporting, Metrics Related to Defects, Using Defects for Process Improvement. Analytic Geometry: Review of Geometry, 2D Analytic Geometry, Intersection Points, Point in Triangle, and Intersection of circle with straight line.
Unit III	Software Quality Assurance : Quality Concepts, Quality Movement, Background Issues, SQA activities, Software Reviews, Formal Technical Reviews, Formal approaches to SQA, Statistical Quality Assurance, Software Reliability, The ISO 9000 Quality Standards, , SQA Plan , Six sigma, Informal Reviews Quality Improvement : Introduction, Pareto Diagrams, Cause-effect Diagrams, Scatter Diagrams, Run charts Quality Costs : Defining Quality Costs, Types of Quality Costs, Quality Cost Measurement, Utilizing Quality Costs for Decision-Making
Textbook(s): 1. Software Engineering for Students, A Programming Approach, Douglas Bell, 4 th Edition,, Pearson Education, 2005 2. Software Engineering – A Practitioners Approach, Roger S. Pressman, 5 th Edition, Tata McGraw Hill, 2001 3. Quality Management, Donna C. S. Summers, 5 th Edition, Prentice-Hall, 2010.	

4. Total Quality Management, Dale H. Besterfield, 3rd Edition, Prentice Hall, 2003.

Additional Reference(s):

1. Software engineering: An Engineering approach, J.F. Peters, W. Pedrycz , John Wiley,2004
2. Software Testing and Quality Assurance Theory and Practice, Kshirsagar Naik, Priyadarshi Tripathy , John Wiley & Sons, Inc. , Publication, 2008
3. Software Engineering and Testing, B. B. Agarwal, S. P. Tayal, M. Gupta, Jones and Bartlett Publishers, 2010

List of Practical- SEMESTER V

Course: RJCSS5P01	Practical of Group I (AI & Linux)
(Credits : 02 Lectures/Week: 06) RJCSS501: Artificial Intelligence	
<p><i>Practical shall be implemented in Python</i></p> <ol style="list-style-type: none">1. Implement Breadth first search algorithm.2. Implement depth first search algorithm.3. Implement decision tree learning algorithm.4. Implement feed forward back propagation neural network learning algorithm.5. Implement Naive Bayes' learning algorithm for the restaurant waiting problem.6. Implement program to design game of shuffle deck of cards.7. Implement program to design the simulation of tic-tac-toe game.8. Implement program to solve tower of Hanoi problem.	
(Credits : 02 Lectures/Week: 06) RJCSS502: Linux Server Administration	
<p>- <i>Practical shall be performed using any Linux Server (with 8GB RAM).</i></p> <p>- <i>Internet connection will be required so that Linux server (command line mode) can be connected to Internet.</i></p>	

1. Install DHCP Server in Ubuntu 16.04
2. Initial settings: Add a User, Network Settings, Change to static IP address, Disable IPv6 if not needed, Configure Services, display the list of services which are running, Stop and turn OFF auto-start setting for a service if you don't need it, Sudo Settings
3. Configure NTP Server (NTPd), Install and Configure NTPd, Configure NTP Client (Ubuntu and Windows)
4. SSH Server : Password Authentication
Configure SSH Server to manage a server from the remote computer, SSH Client : (Ubuntu and Windows)
5. Install DNS Server BIND, Configure DNS server which resolves domain name or IP address, Install BIND 9, Configure BIND, Limit ranges you allow to access if needed.
6. Configure DHCP Server, Configure DHCP (Dynamic Host Configuration Protocol) Server, Configure NFS Server to share directories on your Network, Configure NFS Client. (Ubuntu and Windows Client OS)
7. Configure LDAP Server, Configure LDAP Server in order to share users' accounts in your local networks, Add LDAP User Accounts in the OpenLDAP Server, Configure LDAP Client in order to share users' accounts in your local networks. Install phpLDAPadmin to operate LDAP server via Web browser.
8. Configure NIS Server in order to share users' accounts in your local networks, Configure NIS Client to bind NIS Server.
9. Install MySQL to configure database server, Install phpMyAdmin to operate MySQL on web browser from Clients.
10. Install Samba to share folders or files between Windows and Linux.

Course: RJCSS5P02	Practical of Group II (Security & Web Services)
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(Credits : 02 Lectures/Week: 06)

RJCSS503: Information and Network Security

1. Write programs to implement the following Substitution Cipher Techniques:
 - Caesar Cipher
 - Monoalphabetic Cipher
2. Write programs to implement the following Substitution Cipher Techniques:
 - Vernam Cipher
 - Playfair Cipher

- 3 Write programs to implement the following Transposition Cipher Techniques:
 - Rail Fence Cipher
 - Simple Columnar Technique
- 4 Write program to encrypt and decrypt strings using
 - DES Algorithm
 - AES Algorithm
- 5 Write a program to implement RSA algorithm to perform encryption / decryption of a given string.
- 6 Write a program to implement the Diffie-Hellman Key Agreement algorithm to generate symmetric keys.
- 7 Write a program to implement the MD5 algorithm compute the message digest.
- 8 Write a program to implement SSL.

(Credits : 02 Lectures/Week: 06)

RJCSS504: Web Services

1. Write a program to implement to create a simple web service that converts the temperature from Fahrenheit to Celsius and vice a versa.
2. Write a program to implement to create a simple web service that check whether given number is Armstrong or not.
3. Implement a typical service and a typical client using WCF.
4. Demonstrates using the binding attribute of an endpoint element in WCF.
5. Develop client which consumes web services developed in different platform.
6. Write a JAX-WS web service to perform the following operations. Define a Servlet / JSP that consumes the web service.
7. Define a web service method that returns the contents of a database in a JSON string. The contents should be displayed in a tabular format.
8. Define a RESTful web service that accepts the details to be stored in a database and performs CRUD operation.
9. Build one microservice application that will consume different available services.
10. Create a custom Microservice, which will work as input service for other services.

Course: (Credits : 01 Lectures/Week: 03)

RJCSS5P03 Project Implementation

Please Refer to Project Implementation Guidelines given on last page

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Course:	(Credits : 01 Lectures/Week: 03)
RJCSS5P05	Practical of Skill Enhancement
USCS505 Software Testing and Quality Assurance	
<ol style="list-style-type: none"> 1. Install Selenium IDE; Write a test suite containing minimum 4 test cases for different formats. 2. Conduct a test suite for any two web sites. 3. Install Selenium server (Selenium RC) and demonstrate it using a script in Java/PHP. 4. Write and test a program to login a specific web page. 5. Write and test a program to update 10 student records into table into Excel file 6. Write and test a program to select the number of students who have scored more than 60 in any one subject (or all subjects). 7. Write and test a program to provide total number of objects present / available on the page. 8. Write and test a program to get the number of items in a list / combo box. 9. Write and test a program to count the number of check boxes on the page checked and unchecked count. 10. Load Testing using JMeter, Android Application testing using Appium Tools, Bugzilla Bug tracking tools. 	

SEMESTER VI THEORY

Course: RJSCSS601		TOPICS (Credits : 03 Lectures/Week:03) Wireless Sensor Networks and Mobile Communication	
Objectives: In this era of wireless and adhoc network, connecting different wireless devices and understanding their compatibility is very important. Information is gathered in many different ways from these devices. Learner should be able to conceptualize and understand the framework. On completion, will be able to have a firm grip over this very important segment of wireless network.			
Expected Learning Outcomes: After completion of this course, learner should be able to list various applications of wireless sensor networks, describe the concepts, protocols, design, implementation and use of wireless sensor networks. Also implement and evaluate new ideas for solving wireless sensor network design issues.			
Unit I	Introduction: Introduction to Sensor Networks, unique constraints and challenges. Advantage of Sensor Networks, Applications of Sensor Networks, Mobile Adhoc NETWORKS (MANETs) and Wireless Sensor Networks, Enabling technologies for Wireless Sensor Networks. Sensor Node Hardware and Network Architecture: Single-node architecture, Hardware components & design constraints, Operating systems and execution environments, introduction to TinyOS and nesC. Network architecture, Optimization goals and figures of merit, Design principles for WSNs, Service interfaces of WSNs, Gateway concepts.		15L
Unit II	Medium Access Control Protocols: Fundamentals of MAC Protocols, MAC Protocols for WSNs, Sensor-MAC Case Study. Routing Protocols : Data Dissemination and Gathering, Routing Challenges and Design Issues in Wireless Sensor Networks, Routing Strategies in Wireless Sensor Networks. Transport Control Protocols : Traditional Transport Control Protocols, Transport Protocol Design Issues, Examples of Existing Transport Control Protocols, Performance of Transport Control Protocols.		15L
Unit III	Introduction, Wireless Transmission and Medium Access Control: Applications, A short history of wireless communication. Wireless Transmission: Frequency for radio transmission, Signals, Antennas, Signal propagation, Multiplexing, Modulation, Spread spectrum, Cellular systems. Telecommunication, Satellite and Broadcast Systems: GSM: Mobile services, System architecture, Radio interface, Protocols, Localization And Calling, Handover, security, New data services; DECT: System architecture, Protocol architecture; ETRA, UMTS and IMT- 2000. Satellite Systems: History, Applications, Basics: GEO, LEO, MEO; Routing, Localization, Handover.		15L
Textbook(s): Protocols and Architectures for Wireless Sensor Network, Holger Kerl, Andreas Willig, John Wiley and Sons, 2005 2) Wireless Sensor Networks Technology, Protocols, and Applications ,Kazem Sohraby, Daniel Minoli and TaiebZnati, John Wiley & Sons, 2007 3) Mobile communications, Jochen Schiller,2nd Edition, Addison wisely , Pearson Education,2012 Additional Reference(s): Fundamentals of Wireless Sensor Networks, Theory and Practice, Waltenegus Dargie, Christian			

Poellabauer , Wiley Series on wireless Communication and Mobile Computing, 2011
 2) Networking Wireless Sensors, Bhaskar Krishnamachari , Cambridge University Press, 2005

Course: RJCSS602 **TOPICS (Credits : 03 Lectures/Week:03)**
Cloud Computing

Objectives:

To provide learners with the comprehensive and in-depth knowledge of Cloud Computing concepts, technologies, architecture, implantations and applications. To expose the learners to frontier areas of Cloud Computing, while providing sufficient foundations to enable further study and research.

Expected Learning Outcomes:

After successfully completion of this course, learner should be able to articulate the main concepts, key technologies, strengths, and limitations of cloud computing and the possible applications for state-of-the-art cloud computing using open source technology. Learner should be able to identify the architecture and infrastructure of cloud computing, including SaaS, PaaS, IaaS, public cloud, private cloud, hybrid cloud, etc. They should explain the core issues of cloud computing such as security, privacy, and interoperability.

Unit I	Introduction to Cloud Computing, Characteristics and benefits of Cloud Computing, Basic concepts of Distributed Systems, Web 2.0, Service-Oriented Computing, Utility-Oriented Computing. Elements of Parallel Computing. Elements of Distributed Computing. Technologies for Distributed Computing. Cloud Computing Architecture. The cloud reference model. Infrastructure as a service. Platform as a service. Software as a service. Types of clouds.	15 L
Unit II	Characteristics of Virtualized Environments. Taxonomy of Virtualization Techniques. Virtualization and Cloud Computing. Pros and Cons of Virtualization. Virtualization using KVM, Creating virtual machines, oVirt - management tool for virtualization environment. Open challenges of Cloud Computing	15L
Unit III	OpenStack: Introduction to OpenStack, Understanding cloud computing and openstack, Components of openstack, Relating openstack to the computational resources it controls: OpenStack and hypervisor, OpenStack and storage, OpenStack and network services, OpenStack and cloud terminology. Foss Cloud: Building Private, public and Hybrid cloud in foss.	15L

Textbook(s):

Mastering Cloud Computing, Rajkumar Buyya, Christian Vecchiola, S Thamarai Selvi, Tata McGraw Hill Education Private Limited, 2013

2) OpenStack in Action, V. K. CODY BUMGARDNER, Manning Publications Co, 2016

Additional Reference(s):

OpenStack Essentials, Dan Radez, PACKT Publishing, 2015

2) OpenStack Operations Guide, Tom Fifield, Diane Fleming, Anne Gentle, Lorin Hochstein, Jonathan Proulx, Everett Toews, and Joe Topjian, O'Reilly Media, Inc., 2014

3) <https://www.openstack.org>

Course: RJSCSS603	TOPICS (Credits : 03 Lectures/Week:03) Advanced Database Systems
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Objectives:

What a distributed database management system (DDBMS) is and what its components are How database implementation is affected by different levels of data and process distribution. Also understand the concepts of Temporal, Deductive and XML database.

Expected Learning Outcomes:

- What a distributed database management system is and what its components are.
- How database implementation is affected by different levels of data and process distribution.
- How transactions are managed in a distributed database environment.
- How database design is affected by the distributed database environment.

Unit I	Distributed Database Concepts: Definition of Distributed databases and Distributed Database Management System (DDBMS), Distributed transparent system. DDBMS Architecture, Distributed database design, Design problem of distributed systems, Design, strategies (top-down, bottom-up), Fragmentation, Allocation and replication of fragments. Query Processing Overview, Query Optimization. Distributed Reliability Protocols, Two phase commit protocol, Three phases commit protocol. Parallel Database System: Definition of Parallel Database Systems. Parallel query evaluation: Speed up and scale up, Query Parallelism: I/O Parallelism (Data Partitioning) Intraquery Parallelism, Inter -Query Parallelism, Intra Operation Parallelism, Inter Operation Parallelism.	15L
Unit II	Object Oriented Database: Object Identity, Object structure, Type Constructors , Encapsulation of Operations, Methods, Persistence, Type and Class Hierarchies, Inheritance, Complex Objects, Object-oriented DBMS , Languages and Design: ODMG Model, Object Definition Languages (ODL), Object Query Languages (OQL). Temporal Database: Introduction to Temporal Database: Time ontology, structure, and granularity, Temporal data models, Temporal relational algebras.	15L
Unit III	Deductive Database: Introduction to recursive queries, Datalog Notation, Clause Form and Horn Clauses, Interpretation of model: Least Model semantics, The fixed point operator, safe Datalog program, recursive query with negation. Active Database: Languages for rule specification: Events, Conditions, Actions. XML Database: Structure of XML Data, XML Document Schema, Querying and Transformation, Storage of XML Data..	15L

Textbook(s):

Digital Image Processing, S Jayaraman, S Esakkirajan, T Veerakumar, Tata McGraw-Hill Education Pvt. Ltd., 2009

Additional Reference(s):

- 1) Digital Image Processing 3rd Edition, Rafael C Gonzalez, Richard E Woods, Pearson, 2008
- 2) Scilab Textbook Companion for Digital Image Processing, S. Jayaraman, S. Esakkirajan And T. Veerakumar, 2016 (https://scilab.in/textbook_companion/generate_book/125)

Course: RJSCSS604	TOPICS (Credits : 03 Lectures/Week:03)
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Data Science		
Objectives: Understanding basic data science concepts. Learning to detect and diagnose common data issues, such as missing values, special values, outliers, inconsistencies, and localization. Making aware of how to address advanced statistical situations, Modeling and Machine Learning.		
Expected Learning Outcomes: After completion of this course, the students should be able to understand & comprehend the problem; and should be able to define suitable statistical method to be adopted.		
Unit I	Introduction to Data Science: What is Data? Different kinds of data, Introduction to high level programming language + Integrated Development Environment (IDE), Exploratory Data Analysis (EDA) + Data Visualization, Different types of data sources, Data Management: Data Collection, Data cleaning/extraction, Data analysis & Modeling	15L
Unit II	Data Curation: Query languages and Operations to specify and transform data, Structured/schema based systems as users and acquirers of data, Semi-structured systems as users and acquirers of data, Unstructured systems in the acquisition and structuring of data, Security and ethical considerations in relation to authenticating and authorizing access to data on remote systems, Software development tools, Large scale data systems, Amazon Web Services (AWS)	15L
Unit III	Statistical Modelling and Machine Learning: Introduction to model selection: Regularization, bias/variance tradeoff e.g. parsimony, AIC, BIC, Cross validation, Ridge regressions and penalized regression e.g. LASSO Data transformations: Dimension reduction, Feature extraction, Smoothing and aggregating Supervised Learning: Regression, linear models, Regression trees, Time-series Analysis, Forecasting, Classification: classification trees, Logistic regression, separating hyperplanes, k-NN Unsupervised Learning: Principal Components Analysis (PCA), k-means clustering, Hierarchical clustering, Ensemble methods	15L
Textbook(s): 1)Doing Data Science, Rachel Schutt and Cathy O'Neil, O'Reilly,2013 2) Mastering Machine Learning with R, Cory Lesmeister, PACKT Publication,2015 Additional Reference(s): 1)Hands-On Programming with R, Garrett Grolemund,1 st Edition, 2014 2) An Introduction to Statistical Learning, James, G., Witten, D., Hastie, T., Tibshirani, R.,Springer,2015		

Course: RJSCSS605	TOPICS (Credits : 03 Lectures/Week:03) Skill Enhancement: Ethical Hacking
Objectives: To understand the ethics, legality, methodologies and techniques of hacking.	
Expected Learning Outcomes: Learner will know to identify security vulnerabilities and weaknesses in the target applications. They will	

also know to test and exploit systems using various tools and understand the impact of hacking in real time machines.

Unit I	<p>Information Security : Attacks and Vulnerabilities</p> <p>Introduction to information security : Asset, Access Control, CIA, Authentication, Authorization, Risk, Threat, Vulnerability, Attack, Attack Surface, Malware, Security-Functionality-Ease of Use Triangle</p> <p>Types of malware : Worms, viruses, Trojans, Spyware, Rootkits</p> <p>Types of vulnerabilities : OWASP Top 10 : cross-site scripting (XSS), cross site request forgery (CSRF/XSRF), SQL injection, input parameter manipulation, broken authentication, sensitive information disclosure, XML External Entities, Broken access control, Security Misconfiguration, Using components with known vulnerabilities, Insufficient Logging and monitoring, OWASP Mobile Top 10, CVE Database</p> <p>Types of attacks and their common prevention mechanisms : Keystroke Logging, Denial of Service (DoS /DDoS), Waterhole attack, brute force, phishing and fake WAP, Eavesdropping, Man-in-the-middle, Session Hijacking, Clickjacking, Cookie Theft, URL Obfuscation, buffer overflow, DNS poisoning, ARP poisoning, Identity Theft, IoT Attacks, BOTs and BOTNETs</p> <p>Case-studies : Recent attacks – Yahoo, Adult Friend Finder, eBay, Equifax, WannaCry, Target Stores, Uber, JP Morgan Chase, Bad Rabbit</p>	15L
Unit II	<p>Ethical Hacking – I (Introduction and pre-attack)</p> <p>Introduction: Black Hat vs. Gray Hat vs. White Hat (Ethical) hacking, Why is Ethical hacking needed?, How is Ethical hacking different from security auditing and digital forensics?, Signing NDA, Compliance and Regulatory concerns, Black box vs. White box vs. Black box, Vulnerability assessment and Penetration Testing.</p> <p>Approach : Planning - Threat Modeling, set up security verification standards, Set up security testing plan – When, which systems/apps, understanding functionality, black/gray/white, authenticated vs. unauthenticated, internal vs. external PT, Information gathering, Perform Manual and automated (Tools: WebInspect/Qualys, Nessus, Proxies, Metasploit) VA and PT, How WebInspect/Qualys tools work: Crawling/Spidering, requests forging, pattern matching to known vulnerability database and Analyzing results, Preparing report, Fixing security gaps following the report</p> <p>Enterprise strategy : Repeated PT, approval by security testing team, Continuous Application Security Testing,</p> <p>Phases: Reconnaissance/foot-printing/Enumeration, Phases: Scanning, Sniffing</p>	15L
Unit III	<p>Ethical Hacking :Enterprise Security</p> <p>Phases : Gaining and Maintaining Access : Systems hacking – Windows and Linux – Metasploit and Kali Linux, Keylogging, Buffer Overflows, Privilege Escalation, Network hacking - ARP Poisoning, Password Cracking, WEP Vulnerabilities, MAC Spoofing, MAC Flooding, IPspoofing, SYN Flooding, Smurf attack, Applications hacking : SMTP/Email-based attacks, VOIP vulnerabilities, Directory traversal, Input Manipulation, Brute force attack, Unsecured login mechanisms, SQL injection, XSS, Mobile apps security, Malware analysis : Netcat Trojan, wrapping definition, reverse engineering</p> <p>Phases : Covering your tracks : Steganography, Event Logs alteration</p> <p>Additional Security Mechanisms : IDS/IPS, Honeypots and evasion</p>	15L

	techniques, Secure Code Reviews (Fortify tool, OWASP Secure Coding Guidelines)	
Textbook(s): 1) Certified Ethical Hacker Study Guide v9, Sean-Philip Oriyano, Sybex; Study Guide Edition, 2016 2) CEH official Certified Ethical Hacking Review Guide, Wiley India Edition, 2007 Additional Reference(s): 1) Certified Ethical Hacker: Michael Gregg, Pearson Education, 1st Edition, 2013 2) Certified Ethical Hacker: Matt Walker, TMH, 2011 3) http://www.pentest-standard.org/index.php/PTES_Technical_Guidelines 4) https://www.owasp.org/index.php/Category:OWASP_Top_Ten_2017_Project 5) https://www.owasp.org/index.php/Mobile_Top_10_2016-Top_10 6) https://www.owasp.org/index.php/OWASP_Testing_Guide_v4_Table_of_Contents 7) https://www.owasp.org/index.php/OWASP_Secure_Coding_Practices_-_Quick_Reference_Guide 8) https://cve.mitre.org/ 9) https://access.redhat.com/blogs/766093/posts/2914051 10) http://resources.infosecinstitute.com/applications-threat-modeling/#gref 11) http://www.vulnerabilityassessment.co.uk/Penetration%20Test.html		

List of Practical- SEMESTER VI

Course: RJCSS5P01	Practical of Group I (WSN & Cloud Computing) (Credits : 02 Lectures/Week: 06)
RJCSS601: Wireless Sensor Networks and Mobile Communication	
<i>Practical experiments require software tools like INET Framework for OMNeT++, NetSim , TOSSIM, Cisco packet tracer 6.0 and higher version</i>	
<ol style="list-style-type: none"> 1. Understanding the Sensor Node Hardware. (For Eg. Sensors, Nodes(Sensor mote), Base Station, Graphical User Interface.) 2. Exploring and understanding TinyOS computational concepts:- Events, Commands and Task. <ol style="list-style-type: none"> a. nesC model b. nesC Components 3. Understanding TOSSIM for <ol style="list-style-type: none"> a. Mote-mote radio communication b. Mote-PC serial communication 4. Create and simulate a simple adhoc network 5. Understanding, Reading and Analyzing Routing Table of a network. 6. Create a basic MANET implementation simulation for Packet animation and Packet Trace. 7. Implement a Wireless sensor network simulation. 8. Create MAC protocol simulation implementation for wireless sensor Network. 	
RJCSS602: Cloud Computing	

1. Study and implementation of Infrastructure as a Service.
2. Installation and Configuration of virtualization using KVM.
3. Study and implementation of Infrastructure as a Service
4. Study and implementation of Storage as a Service
5. Study and implementation of identity management
6. Study Cloud Security management
7. Write a program for web feed.
8. Study and implementation of Single-Sign-On.
9. User Management in Cloud.
10. Case study on Amazon EC2/Microsoft Azure/Google Cloud Platform

Course:	Practical of Group II (DIP & Data Science)
RJCSS6P02	(Credits : 02 Lectures/Week: 06)

RJSCSS603: Advance Database Systems

1. For a given a global conceptual schema, divide the schema into vertical fragments and place them on different nodes. Execute queries on these fragments that will demonstrate distributed databases environment.
2. For a given a global conceptual schema, divide the schema into horizontal fragments and place them on different nodes. Execute queries on these fragments that will demonstrate distributed databases environment.
3. For a given a global conceptual schema, divide the schema into vertical fragments and place them on different nodes. Insert records using triggers Execute queries on these fragments that will demonstrate distributed databases environment.
4. For a given a global conceptual schema, divide the schema into horizontal fragments and place them on different nodes. Insert records using triggers Execute queries on these fragments that will demonstrate distributed databases environment.
5. Create a nested table and insert sufficient number of tuples and execute queries,
6. Practical on object oriented concepts.
7. Create a temporal database and issue queries on it.
8. Formulate a database using active rules with row and statement level.
9. Demonstrate the concept of Deductive database.
10. Create a XML data base and demonstrate insert, update and delete operations.

RJSCSS604: Data Science

Practical shall be performed using R

1. Practical of Data collection, Data curation and management for Unstructured data (NoSQL)
2. Practical of Data collection, Data curation and management for Large-scale Data system (such as MongoDB)
3. Practical of Principal Component Analysis

4. Practical of Clustering
5. Practical of Time-series forecasting
6. Practical of Simple/Multiple Linear Regression
7. Practical of Logistics Regression
8. Practical of Hypothesis testing

Course: RJCSS6P03	(Credits : 01 Lectures/Week: 03) Project Implementation
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Please Refer to Project Implementation Guidelines

Course: RJCSS6P05	(Credits : 01 Lectures/Week: 03) Practical of Skill Enhancement
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USCS605: Ethical Hacking

1. Use Google and Whois for Reconnaissance
2. a) Use CrypTool to encrypt and decrypt passwords using RC4 algorithm
b) Use Cain and Abel for cracking Windows account password using Dictionary attack and to decode wireless network passwords
3. a) Run and analyze the output of following commands in Linux – ifconfig, ping, netstat, traceroute
b) Perform ARP Poisoning in Windows
4. Use NMap scanner to perform port scanning of various forms – ACK, SYN, FIN, NULL, XMAS
5. a) Use Wireshark (Sniffer) to capture network traffic and analyze
b) Use Nemesy to launch DoS attack
6. Simulate persistent cross-site scripting attack
7. Session impersonation using Firefox and Tamper Data add-on
8. Perform SQL injection attack
9. Create a simple keylogger using python
10. Using Metasploit to exploit (Kali Linux)

Project Implementation Guidelines

1. A learner is expected to carry out two different projects: one in Semester V and another in Semester VI.
2. A learner can choose any topic which is covered in Semester I- semester VI or any other topic with the prior approval from head of the department/ project in charge.
3. The Project has to be performed individually.
4. A learner is expected to devote around three months of efforts in the project.
5. The project can be application oriented/web-based/database/research based.
6. It has to be an implemented work; just theoretical study will not be acceptable.
7. A learner can choose any programming language, computational techniques and tools which have been covered during BSc course or any other with the prior permission of head of the department/ project guide.
8. A project guide should be assigned to a learner. He/she will assign a schedule for the project and hand it over to a learner. The guide should oversee the project progress on a weekly basis by considering the workload of 3 lectures as assigned.
9. The quality of the project will be evaluated based on the novelty of the topic, scope of the work, relevance to the computer science, adoption of emerging techniques/technologies and its real-world application.
10. A learner has to maintain a project report with the following subsections

a) Title Page

b) Certificate

A certificate should contain the following information –

- The fact that the student has successfully completed the project as per the syllabus and that it forms a part of the requirements for completing the BSc degree in computer science of University of Mumbai.
- The name of the student and the project guide
- The academic year in which the project is done
- Date of submission,
- Signature of the project guide and the head of the department with date along with the department stamp,
- Space for signature of the university examiner and date on which the project is evaluated.

c) Self-attested copy of Plagiarism Report from any open source tool.

d) Index Page detailing description of the following with their subsections:

- Title: A suitable title giving the idea about what work is proposed.
- Introduction: An introduction to the topic giving proper back ground of the topic.
- Requirement Specification: Specify Software/hardware/data requirements.
- System Design details : Methodology/Architecture/UML/DFD/Algorithms/protocols etc. used(whichever is applicable)

- System Implementation: Code implementation
- Results: Test Cases/Tables/Figures/Graphs/Screen shots/Reports etc.
- Conclusion and Future Scope: Specify the Final conclusion and future scope
- References: Books, web links, research articles, etc.

11. The size of the project report shall be around twenty to twenty five pages, excluding the code.

12. The Project report should be submitted in a spiral bound form

13. The Project should be certified by the concerned Project guide and Head of the department.

14. A learner has to make a presentation of working project and will be evaluated as per the Project evaluation scheme

Scheme of Examination

1. Theory:

I. Internal 20 Marks :

20 marks test – Duration 30 mins

This test will be based on objective based questions

II. Internal 20 Marks:

20 marks test – Duration 30 mins

This test will be based on subjective, logical or programming based questions

III. External 60 Marks:

IV. Practical and Project Examination:

There will be separate Practical examination for Group-I, II, Skill enhancement and project of these Group-I 100, Group-II: 100 and Skill Enhancement: 50 and Project Implementation: 50.

In the Practical Examination of Group -I and II, the student has to perform practical on each of the subjects chosen. The Marking Scheme for each of the Group is given below:

	Subject Code	Experiment-I	Experiment-II	Total Marks
Group I	RJCSS5P01/ RJCSS6P01	Experiment-40+Journal-5+viva-5 Total:50M	Experiment-40+Journal-5+viva-5 Total:50M	100M
Group II	RJCSS5P02/ RJCSS6P02	Experiment-40+Journal-5+viva-5 Total:50M	Experiment-40+Journal-5+viva-5 Total:50M	100M
Project Implementation	RJCSS5P03/ RJCSS6P03	**Project Evaluation Scheme		50M
Skill Enhancement	RJCSS5P04/ RJCSS6P04	Experiment-40+Journal:5+viva-5 Total-50M		50M
Toatl Marks				300M

(Certified Journal is compulsory for appearing at the time of Practical Examination)

****Project Evaluation Scheme:**

Presentation	Working of the Project	Quality of the Project	Viva	Documentation
10Marks	10 Marks	10 Marks	10 Marks	10 Marks

(Certified Project Document is compulsory for appearing at the time of Project Presentation)
