S.P. Mandali's

RAMNARAIN RUIA AUTONOMOUS COLLEGE

Syllabus for: T.Y.B.Sc

Program: B.Sc

Course Code: Computer Science (RUSCS)

(Choice Based Credit System (CBCS) with effect from academic year 2019-20)

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.

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 VI student has to undertake a Project. In order to give students a real world experience to handle clients while working on projects, we start the initial phases of the project in Semester V. The Analysis & Designing phases are completed in Semester V and in Semester VI students start implementation of the project. This practice will 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 .

Proposed Curriculum contains challenging and varied subjects aligned with the current trend with the Introduction of Artificial Intelligence, Information Retrieval, Data Management related subjects such as Cloud Computing and Data Science. 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.

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 Ramnarain Ruia Autonomous college will accept it.

T.Y.B.Sc. (Semester V and VI)
Computer Science Syllabus
Credit Based Semester and Grading System
To be implemented from the Academic year 2019-2020

SEMESTER – V (THEORY)			
COURSE CODE	**TOPICS**	**CREDITS**	**LECTURES / WEEK**
RUSCS501	Artificial Intelligence	3	3
RUSCS502	Software Testing and Quality Assurance	3	3
RUSCS503	Information and Network Security	3	3
RUSCS504	Web Services	3	3
RUSCS505	Skill Enhancement : Ethical Hacking	2	3

SEMESTER – V (PRACTICALS)			
COURSE CODE	**TOPICS**	**CREDITS**	**LECTURES / WEEK**
RUSCSP501	Practical of Artificial Intelligence	1	3
RUSCSP502	Practical of Software Testing and Quality Assurance	1	3
RUSCSP503	Practical of Information and Network Security	1	3
RUSCSP504	Practical of Web Services	1	3
RUSCSP505	Practical of Skill Enhancement :Ethical Hacking	1	3
RUSCSP506	Practical of Advanced Web Programming	1	3

SEMESTER – VI (THEORY)			
COURSE CODE	**TOPICS**	**CREDITS**	**LECTURES / WEEK**
RUSCS601	Cloud Computing	3	3
RUSCS602	Cyber Forensics	3	3
RUSCS603	Information Retrieval	3	3
RUSCS604	Data Science	3	3
RUSCS605	Skill Enhancement: Optimization Techniques	2	3

SEMESTER – VI(PRACTICALS)			
COURSE CODE	**TOPICS**	**CREDITS**	**LECTURES / WEEK**
RUSCSP601	Practical of Cloud Computing	1	3
RUSCSP602	Practical of Cyber Forensics	1	3
RUSCSP603	Practical of Information Retrieval	1	3
RUSCSP604	Practical of Data Science	1	3
RUSCSP605	Project Implementation	2	6

SEMESTER V - THEORY

COURSE CODE	COURSE NAME	CREDITS	LECTURE/WEEK
RUSCS501	**RUSCS501** **Artificial Intelligence**	**3**	**3**

Learning 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

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, Practical Machine Learning	15L
Unit III	**Learning probabilistic models**: Statistical Learning, Learning with Complete Data, Learning with Hidden Variables: The EM Algorithm. Reinforcement learning: Passive Reinforcement Learning, Active Reinforcement Learning, Generalization in Reinforcement Learning, Policy Search, Applications of Reinforcement Learning..	15L

Textbook(s):

1) 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 CODE	COURSE NAME	CREDITS	LECTURE/WEEK
RUSCS502	**Software Testing and Quality Assurance**	3	3

Learning 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 Software Testing Techniques : Testing Fundamentals, Test Case Design, White Box Testing and its types, Black Box Testing and its types. **Software Testing Strategies :** Strategic Approach to Software Testing, Unit Testing, Integration Testing, Validation Testing, System Testing	15L
Unit II	**Software Metrics :** Concept and Developing Metrics, Different types of Metrics, Complexity metrics. **Verification and Validation :** Definition of V &V , Different types of V & V Mechanisms, Concepts of Software Reviews, Inspection and Walkthrough Defect Management: Definition of Defects, Defect Management Process, Defect Reporting, Metrics Related to Defects, Using Defects for Process Improvement.	15L
Unit III	**Test Techniques :** Equivalence Partitioning, Boundary Value Analysis, Decision Tables, State-Based Testing and State Transition Diagrams, State Transition Tables, Control-Flow Testing, Statement Coverage, Decision Coverage, Loop Coverage, Path Testing, Cyclomatic Complexity, Data Flow Testing Structure-Based Testing **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	15L

References:

1. Software Engineering for Students, A Programming Approach, Douglas Bell, 4th Edition,, Pearson Education, 2005

2. Software Engineering - A Practitioners Approach, Roger S. Pressman, 5th Edition, Tata McGraw Hill, 2001

3. Quality Management, Donna C. S. Summers, 5th Edition, Prentice-Hall, 2010.

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

5. Advanced Software Testing—Vol. 3 by Rex Black and Jamie L. Mitchell, Rocky Nook Publication

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

COURSE CODE	COURSE NAME	CREDITS	LECTURE/WEEK
RUSCS503	**Information and Network Security**	**3**	**3**

Learning Objectives:
To provide students with knowledge of basic concepts of computer security including network security and cryptography.

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 to Network Security:** Security Trends, The OSI Security Architecture, Security Attacks, Security Services, Security Mechanisms **Classical Encryption Techniques:** Symmetric Cipher Model, Substitution Techniques, Transposition Techniques, 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, Digital Envelope. **Authentication Applications:** Kerberos, X.509 Authentication, Public-Key Infrastructure.	15L
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

References:

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 Code:	COURSE NAME	CREDITS	LECTURE/WEEK
RUSCS504	**Web Services**	**3**	**3**

Learning 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

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	**Web services basics :** What Are Web Services? Types of Web Services Distributed computing infrastructure, , Building Web Services with JAX-WS, Registering and Discovering Web Services, Service Oriented Architecture, Web Services Development Life Cycle	15L
Unit II	**Spring Web Services:** Spring WS – Overview, Spring WS - Static WSDL, Spring WS – Writing Server, Spring WS - Unit Test Server, Spring WS - Writing Client, Spring WS - Unit Test Client, use of web Service in Android and testing	15L
Unit III	**Developing Service-Oriented Applications with WCF :** What Is Windows Communication Foundation, Fundamental Windows Communication Foundation Concepts, Windows Communication Foundation Architecture, WCF and .NET Framework Client Profile, Basic WC Programming, WCF Feature Details. Web Service QoS	15L

References:

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) DevelopingService-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 6Tutorial, Oracle, 2013.

Course Code:	COURSE NAME	CREDITS	LECTURE/WEEK
RUSCS505	**Ethical Hacking**	**2**	**3**

Learning Objectives:

To understand the ethics, legality, methodologies and techniques of hacking.

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	**Information Security** : Asset, Threat, Vulnerability, Attack, Exploit, Types of malware, Access Control, CIA, Risk. **Introduction to Ethical Hacking -** Objective of Ethical, Hacking, Asset, Vulnerability Threat, Expolit Ethical hacking types, Hacker types, Vulnerability assessment and Penetration Testing. **Phases of Ethical hacking** : Footprinting, Reconnaince, scanning, Enumeration	15L
Unit II	**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 **Vulnerability Assessment and Penetration Testing (VAPT) Process:** Introduction to VA and PT, Threat modeling, Categories of Penetration Test, Tools used like WebInspect/Qualys, Nessus, Differences in VA and PT	15L
Unit III	**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,, Cookie Theft, URL Obfuscation, buffer overflow, DNS poisoning, ARP poisoning, Identity Theft, IOT Attacks, BOTs and BOTNETs, Keylogging, Buffer Overflows, Privilege Escalation, 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, **,** SQL injection, XSS, Intellectual property theft, Vulnerability Assessment and Penetration Testing (VAPT) Process,Instant messanger threats,Evading IDS **Enforcement of security**:Firewall,Secure coding practices, Security policy	15L

References

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. http://www.pentest-standard.org/index.php/PTES_Technical_Guidelines
2. https://www.owasp.org/index.php/Category:OWASP_Top_Ten_2017_Project
3. https://www.owasp.org/index.php/Mobile_Top_10_2016-Top_10

4. https://www.owasp.org/index.php/OWASP_Testing_Guide_v4_Table_of_Contents
5. https://www.owasp.org/index.php/OWASP_Secure_Coding_Practices_-_Quick_Reference_
     Guide
6. https://cve.mitre.org/
7.   https://access.redhat.com/blogs/766093/posts/2914051
8. http://resources.infosecinstitute.com/applications-threat-modeling/#gref
9. http://www.vulnerabilityassessment.co.uk/Penetration%20Test.html

SEMESTER V - PRACTICALS

Course Code:	COURSE NAME	CREDITS	LECTURE/WEEK
RUSCSP501	**Practical of RUSCS501: Artificial Intelligence**	1	3
	Practical shall be implemented in LISP /Python 1. Implement Breadth first search algorithm for Romanian map problem. 2. Implement Iterative deep depth first search for Romanian map problem. 3. Implement A* search algorithm for Romanian map problem. 4. Implement recursive best-first search algorithm for Romanian map problem. 5. Implement decision tree learning algorithm for the restaurant waiting problem. 6. Implement feed forward back propagation neural network learning algorithm for the restaurant waiting problem. 7. Implement Adaboost ensemble learning algorithm for the restaurant waiting problem. 8. Implement Naive Bayes' learning algorithm for the restaurant waiting problem. 9. Implement passive reinforcement learning algorithm based on adaptive dynamic programming (ADP) for the 3 by 4 world problem 10. Implement passive reinforcement learning algorithm based on temporal differences (TD) for 3 by 4 world problem.		

Course Code:	COURSE NAME	CREDITS	LECTURE/WEEK
RUSCSP502	**Practical of RUSCS502: Software Testing and Quality Assurance**	1	3
	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.

Course Code:	COURSE NAME	CREDITS	LECTURE/WEEK
RUSCSP503	**Practical of RUSCS503: Information and Network security**	1	3

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 calculate HMAC-SHA1 Signature
9   Write a program to implement SSL.
10 Configure Windows Firewall to block:

-	A port	
-	An Program	
-	A website	

Course Code:	COURSE NAME	CREDITS	LECTURE/WEEK
RUSCSP504	**Practical of RUSCS504: Web Services**	**1**	**3**
	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 the operation can receive request and will return a response in two ways. a) One - Way operation b) Request -Response 3. Write a program to implement business UDDI Registry entry. 4. Develop client which consumes web services developed in different platform. 5. Write a JAX-WS web service to perform the following operations. Define a Servlet / JSP that consumes the web service. 6. 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. 7. Define a RESTful web service that accepts the details to be stored in a database and performs CRUD operation. 8. Implement a typical service and a typical client using WCF. 9. Use WCF to create a basic ASP.NET Asynchronous JavaScript and XML (AJAX) service. 10. Demonstrates using the binding attribute of an endpoint element in WCF. 11.Demonstrate practicals on Spring in Web services		

Course Code:	COURSE NAME	CREDITS	LECTURE/WEEK
RUSCSP505	**Practical of RUSCS505: Skill Enhancement : Ethical Hacking**	**1**	**3**
	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		

Course Code:	COURSE NAME	CREDITS	LECTURE/WEEK
	5. a) Use Wireshark (Sniffer) to capture network traffic and analyze 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 logger using python		
RUSCSP506	**Practical of Advanced Web Programming**	1	3
	1. Write a program to read the data & display it on the page simultaneously. 2. Write a program to change the name displayed on the textbox. 3. Write a program using ng-bind. 4. Working with filters. 5. Exploring AngularJS services. 6. Program using AngularJS tables. 7. Working with AngularJS Events. 8. Working with AngularJS forms & validations. 9. Exploring AngularJS Animations 10. Develop an application using AngularJS		

SEMESTER VI - THEORY

Course Code:		COURSE NAME	CREDITS	LECTURE/WEEK
RUSCS601		**Cloud Computing**	3	3

Learning 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.

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.	15L
Unit II	**Virtualization:** Characteristics of Virtualized Environments. Taxonomy of Virtualization techniques. Virtualization and Cloud Computing. Pros and Cons ofVirtualization. Virtualization using KVM, Creating virtual machines, oVirt - management tool for virtualization environment. Open challenges of Cloud Computing.	15L
Unit III	**Introduction to OpenStack technologies:** OpenStack test-drive, Basic OpenStack operations, OpenStack CLI and APIs, Tenant model operations, Quotas, Private cloud building blocks, Controller deployment, Networking deployment, Block Storage deployment, Compute deployment, deploying and utilizing OpenStack in production environments, Building a production environment, Application or chestration using OpenStack Heat	15L

References:

1) 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):

1) 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 Code:	COURSE NAME	CREDITS	LECTURE/WEEK
RUSCS602	**Cyber Forensics**	3	3

Learning Objectives:

To understand the procedures for identification, preservation, and extraction of electronic evidence, auditing and investigation of network and host system intrusions, analysis and documentation of information gathered

Learning Outcomes :

The student will be able to plan and prepare for all stages of an investigation - detection, initial response and management interaction, investigate various media to collect evidence, report them in a way that would be acceptable in the court of law.

Unit I	**Computer Forensics :** Introduction to Computer Forensics, Understanding Computer Investigations, Data Acquisition. Processing Crime and Incident Scenes. **Network Forensic :** Introduction to Network Forensics and its challenges, Types of Digital evidence,Souces of Network based Evidence, Sources of log./ **Cell Phone and Mobile Device Forensics:** Overview, Acquisition Procedures for Cell Phones and Mobile Devices.	15L
Unit II	**Internet Forensic :** Introduction to Internet Forensics, World Wide Web Threats, Hacking and Illegal access, Obscene and Incident transmission, Domain Name Ownership Investigation, Reconstructing past internet activities and events **E-mail Forensics :** e-mail analysis, e-mail headers and spoofing, Laws against e-mail Crime, Messenger Forensics **Social Media Forensics:** Social Media Investigations **Browser Forensics:** Cookie Storage and Analysis, Analyzing Cache and temporary internet files, Web browsing activity reconstruction	15L
Unit III	**Legal aspects and Ethics of Digital Forensics:** Expert Testimony in High-Tech Investigations, Information Technology Act. **Case Study :** Cyber Crime cases	15L

References:

1. Guide to computer forensics and investigations, Bill Nelson, Amelia Philips and Christopher
Steuart, course technology,5th Edition,2015

2. Network Forensics, Sherri Davidoff, Jonathan HAM, Prentice Hall, 2012.

Additional Reference(s):

1) Introduction to Social Media Investigation A Hands-on Approach, Jennifer Golbeck Judith L. Klavans, Technical Editor

Course Code:	COURSE NAME	CREDITS	LECTURE/WEEK
RUSCS603	**Information Retrieval**	3	3

Learning Objectives:

To provide an overview of the important issues in classical and web information retrieval. The focus is to give an up-to- date treatment of all aspects of the design and implementation of systems for Gathering, indexing, and searching documents and of methods for evaluating systems.

Learning Outcomes:

After completion of this course, learner should get an understanding of the field of information retrieval and its relationship to search engines. It will give the learner an understanding to apply Information retrieval models.

Unit I	**Introduction to Information Retrieval:** Introduction, History of IR, Components of IR, and Issues related to IR, Boolean retrieval, Dictionaries and tolerant retrieval.	15L
Unit II	**Link Analysis and Specialized Search:** Link Analysis, hubs and authorities, Page Rank and HITS algorithms, Similarity, Hadoop & MapReduce, Evaluation, Personalized search, Collaborative filtering and content-based recommendation of documents and products, handling "invisible" Web, Snippet generation, Summarization, Question Answering, Cross- Lingual Retrieval.	15L
Unit III	**Web Search Engine:** Web search overview, web structure, the user, paid placement, search engine optimization/spam, Web size measurement, search engine optimization/spam, Web Search Architectures. **XML retrieval:** Basic XML concepts, Challenges in XML retrieval, A vector space model for XML retrieval, Evaluation of XML retrieval, Text-centric versus data-centric XML retrieval.	15L

References:

1) Introduction to Information Retrieval, C. Manning, P. Raghavan, and H. Schütze, Cambridge University Press, 2008

2) Modern Information Retrieval: The Concepts and Technology behind Search, Ricardo Baeza

-Yates and Berthier Ribeiro - Neto, 2nd Edition, ACM Press Books 2011.

3) Search Engines: Information Retrieval in Practice, Bruce Croft, Donald Metzler and Trevor Strohman, 1st Edition, Pearson, 2009.

Additional Reference(s):

1) Information Retrieval Implementing and Evaluating Search Engines, Stefan Büttcher, Charles L. A. Clarke and Gordon V. Cormack, The MIT Press; Reprint edition (February 12, 2016)

Course Code:	COURSE NAME	CREDITS	LECTURE/ WEEK
RUSCS60 4	**Data Science**	3	3

Learning Objectives:

Understanding Data Science Process and learning techniques, tools, Statistical Methodologies and Machine learning algorithms used in the process.

Learning Outcomes:

After completion of this course, the students should be able to understand & comprehend Data science problem; and should be able to provide analytical solution to it.

Unit I	**Introduction to Data Science:** What is Data? Different kinds of data, Data Science Process or lifecycle. **Data Preprocessing:** Descriptive Data Summarization, Data Cleaning, Data Integration and Transformation, Data Reduction, Data Discretization and Concept Hierarchy Generation **Exploratory Data Analysis (EDA):** Measures of central tendency and dispersion, Bar plot, histogram, Box plots, stem-leaf diagram, multi-dimensional modeling	15L
Unit II	**Statistical Modeling and Machine Learning Algorithms:** Introduction to model selection: Regularization, bias/variance tradeoff e.g.parsimony, AIC, BIC, Cross validation **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, Density-Based Methods, Grid-Based Methods, Model-Based Clustering Methods, Clustering High-Dimensional Data, Constraint-Based Cluster Analysis, Outlier Analysis, Association rules from frequent itemsets. Ensemble methods: Increasing the Accuracy, Model Selection.	15L
Unit III	**Semi-structured systems:** Semi-structured data Model, management and querying of data. **Unstructured data analytics systems:** Unstructured data model, NoSQL databases, Text Analytics **Big data Analytics:** What is Big data? ,Document shingling	15L

Textbook(s):

1. Doing Data Science, Rachel Schutt and Cathy O'Neil, O'Reilly,2013
2. J. Han and M. Kamber, " Data Mining: Concepts and Techniques", Second Edition, Elsevier, Reprinted2008
3. Elmasri and Navathe, "Fundamentals of Database Systems", Pearson Education
4. Hadoop The Definitive Guide, Tom White, O'Reilly

5. Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data, EMC Education Services
6. Big Data Analytics with R and Hadoop, Vignesh Prajapati, PACKT Publishing.
7. Mining of Massive Datasets, Anand Rajaraman and Jeffrey David Ullman, Cambridge University Press, 2012

Additional Reference(s):
1) Hands-On Programming with R, Garrett Grolemund,1st Edition, 2014
2) An Introduction to Statistical Learning, James, G., Witten, D., Hastie, T., Tibshirani, R.,Springer,2015

Course Code:	COURSE NAME	CREDITS	LECTURE/WEEK
RUSCS605	**Optimization techniques**	2	3

Learning Objectives
Many real-world problems require advanced techniques to formulate and to solve, and sometimes new optimization algorithms and procedures need to be designed. The objective of this subject is to help students become optimizers, who have solid understanding of basic theory and also practical skills to model and solve real-world problems

Learning Outcomes:
After successful completion of the course, student will be able to understand importance of optimization of industrial process management .Student will learn ways of solving optimization problems that are too hard, too large for direction solution and how to solve optimization problems faster when speed is essential.

Unit I	**Introduction to Operation Research:** Operation Research approach, scientific methods, introduction to models and modeling techniques, general methods for Operation Research models, methodology and advantages of Operation Research, history of Operation Research. **Linear Programming (LP):** Introduction to LP and formulation of Linear Programming problems, Graphical solution method, alternative or multiple optimal solutions, Unbounded solutions, Infeasible solutions, Maximization – Simplex Algorithm, Minimization – Simplex Algorithm using Big-M method, Two phase method, Duality in linear programming	15L
Unit II	**Transportation & Assignment Problems:** Introduction to Transportation problems, various methods of Transportation problem, Variations in Transportation problem, introduction to Assignment problems, variations in Assignment problems. traveling salesman problem. **Integer LP Models** Gomary's Cutting plane algorithms, branch and bound technique for integer programming	15L

Unit III	**Sequencing:** Introduction, processing N jobs through two machines, processing N jobs through three machines, processing N jobs through m machines. **Theory of Games**: Introduction, Two person Zero sum Games, Games with Saddle point	15L

References:

1) Operation research theory and Applications,J.K.Sharma,5th Edition, MacMillan Publishing Co

Additional Reference(s):

1) Taha H.A. - Operations Research; An Introduction, 7th ed.,2003, MacMillan Publishing Co.

SEMESTER VI - PRACTICALS

Course Code:	COURSE NAME	CREDITS	LECTURE/WEEK
RUSCSP601	**Practical of RUSCS601: Cloud Computing**	**1**	**3**

	1. Implementation of Infrastructure as a Service
	    a. VMWare Esxi Server
	    b. Citrix Xen Server
	2. Implementation of Remote Procedure Calls
	3. Implementation of Remote Method Invocation on Local machine as well as Remote machine
	4. Implementing Hadoop & Map Reduce
	5. Application Development using Google App Engine
	6. Installation and configuration of virtualization using KVM
	7. Installation and configuration of OpenStack
	8. Study of AWS
	9. Study of Google Cloud
	10. Study of Windows Azure		

Course Code:	COURSE NAME	CREDITS	LECTURE/WEEK
RUSCSP602	**Practical of RUSCS602: Cyber Forensics**	**1**	**3**
	Make use of Forensics tools to perform following: 1.Evidence acquisition 2. Cyber Forensics Case examination 3. Network Forensics 4. Network Tracking and Process Monitoring		

5. Mobile Forensics
6. Email Forensics
7. Browser Forensics
8. Write a program for Database backup and its restoring.

Course Code:	COURSE NAME	CREDITS	LECTURE/WEEK
RUSCSP603	**Practical of RUSCS603: Information Retrieval**	1	3

Practical may be done using software/tools like Python / Java / Hadoop
1. Write a program to demonstrate bitwise operation.
2. Implement Page Rank Algorithm.
3. Implement Dynamic programming algorithm for computing the edit distance between strings s1 and s2. (Hint. Levenshtein Distance)
4. Write a program to Compute Similarity between two text documents.
5. Write a map-reduce program to count the number of occurrences of each alphabetic Character in the given dataset. The count for each letter should be case-insensitive (i.e., include both upper-case and lower-case versions of the letter; Ignore non-alphabetic Characters).
6. Implement a basic IR system using Lucene.
7. Write a program for Pre-processing of a Text Document: stop word removal.
8. Write a program for mining Twitter to identify tweets for a specific period and identify trends and named entities.
9. Write a program to implement simple web crawler.
10. Write a program to parse XML text, generate Web graph and compute topic specific page rank.

Course Code:	COURSE NAME	CREDITS	LECTURE/WEEK
RUSCSP604	**Practical of RUSCS604: Data Science**	1	3

1. Data Cleaning
2. Exploratory Data Analysis
3. Regression
4. Decision Tree
5. Principal Component Analysis
6. Clustering
7. Association
8. Model validation

| 9. NoSQL database |
| 10. Document shingling |

Course Code:	COURSE NAME	CREDITS	LECTURE/WEEK
RUSCSP605	**Project Implementation**	**8**	**3**

Project Implementation Guidelines

1. A learner is expected to carry out one project: 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 minimum 180hrs 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

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 it's 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 which wil be evaluated .

MODALITY OF ASSESSMENT

Theory Examination Pattern

A) Internal Assessment - 40% :40 marks.

Sr No	Evaluation type	Marks
1	It will be conducted either using any open source learning management system such as Moodle (Modular object-oriented dynamic learning environment)	20
2	Project (group of 5 students)/Tutorial/Quizzes/Assignment	20

B) External examination - 60 %

External Examination- 60 Marks Duration 2 Hrs

Theory Question Paper Pattern:-

All Questions are Compulsory			
Questions	Options	Based On	Marks
Q1	Any 3 out of 5	Unit I, II, & III	15
Q2	Any 3 out of 5	Unit I	15
Q3	Any 3 out of 5	Unit II	15
Q4	Any 3 out of 5	Unit III	15

- All questions shall be compulsory with internal choice within the questions.

Practical Examination Pattern

(A) Internal Examination: Internal Practical - 20 Marks
10 Marks - Individual Practical Implementation & Performance

- Each student will maintain an e-journal. After every practical students will upload his practicals in the form of documents along with the screen shots of output on online portal (Moodle/Google site/any LMS).

10 Marks –Design and implement innovative application of the technology

Heading	Practical
Individual Practical Implementation & Performance	10

Design and implement innovative application of the technology	10
Total	20

(B) External (Semester end practical examination): 30 Marks
30 Marks Practical Questions:

- Student has to acquire atleast 40% marks in each paper individually.

PASSING CRITERIA 40%: - Student has to acquire minimum of 40% marks each course (Theory and Practical) both.

Particulars	Practical
Laboratory work	30
Total	**30**

PROJECT

INTERNAL COMPONENT - 40 Marks

- Project Proposal - 10 Marks
- Analysis Phase - 10 Marks
- Design Phase - 10 Marks
- Implementation - 10 Marks

Marking Scheme

- o Each student has to follow the schedule for above mentioned phases as given by the Project Guide.
- o Marks will be allotted on the basis of the presentation made by the student at each stage of project development.
- o Students has to maintain regular phases completion chart and project documentation duly signed By internal guide

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EXTERNAL COMPONENT - 60 Marks

- Project Quality - 20 Marks.
- Working of Project - 20 Marks.
- Student Presentation - 20 Marks.

PASSING CRITERIA 40%: - **Student has to acquire minimum of 40% marks each course (Theory/Practical/Project) both.**

E-JOURNAL

The students are required to submit a duly certified journal soft copy on Google classroom for appearing at the practical examination, failing which they will not be allowed to appear for the examination.

Overall Examination and Marks Distribution Pattern

Semester- V

Course	*Theory: RUSCS501,502,503,504,505.* *Practical: RUSCSP501,502,503,504,505,506.*		
	Internal	**External**	**Total**
Theory	40	60	500
Practicals	20	30	300

Semester- VI

Course	*Theory: RUSCS601,602,603,604,605.* *Practical: RUSCSP601,602,603,604,605.*		
	Internal	**External**	**Total**
Theory	40	60	500

Practicals	20	30	300