Resolution No: AC/II(21-22).2.RUS6

S. P. Mandali's

Ramnarain Ruia Autonomous College

(Affiliated to University of Mumbai)

Syllabus for TYBSc

Program: B.Sc (Computer Science)

Program Code: Computer Science (RUSCS)

(Credit Based Semester and Grading System
for academic year 2021–2022)

PROGRAM OUTLINE

T.Y.B.Sc (Computer Science)							
SEMESTER – V (THEORY)					SEMESTER – V (PRACTICALS)		
YEAR	SEM	COURSE CODE	COURSE TITLE	CREDITS	COURSE CODE	COURSE TITLE	CREDITS
T.Y.Bsc	V	RUSCS501	Artificial Intelligence	3	RUSCSP501	Practical of Artificial Intelligence	1
T.Y.Bsc	V	RUSCS502	Software Testing and Quality Assurance	3	RUSCSP502	Practical of Software Testing and Quality Assurance	1
T.Y.Bsc	V	RUSCS503	Information and Network Security	3	RUSCSP503	Practical of Information and Network Security	1
T.Y.Bsc	V	RUSCS504	Web Services	3	RUSCSP504	Practical of Web Services	1
T.Y.Bsc	V	RUSCS505	Skill Enhancement : Ethical Hacking	2	RUSCSP505	Practical of Skill Enhancement :Ethical Hacking	1
T.Y.Bsc	V	-----	----	----	RUSCSP506	Practical of Advanced Web Programming	1

T.Y.B.Sc (Computer Science)							
SEMESTER – VI (THEORY)					SEMESTER – VI (PRACTICALS)		
YEAR	SEM	COURSE CODE	COURSE TITLE	CREDITS	COURSE CODE	COURSE TITLE	CREDITS
T.Y.Bsc	VI	RUSCS601	Cloud Computing	3	RUSCSP601	Practical of Cloud Computing	1
T.Y.Bsc	VI	RUSCS602	Cyber Forensics	3	RUSCSP602	Practical of Cyber Forensics	1
T.Y.Bsc	VI	RUSCS603	Information Retrieval	3	RUSCSP603	Practical of Information Retrieval	1

T.Y.Bsc	**VI**	**RUSCS604**	Data Science	3	**RUSCSP604**	Practical of Data Science	1
T.Y.Bsc	**VI**	**RUSCS605**	Skill Enhancement: Optimization Techniques	2	**RUSCSP605**	Project Implementation	2

Course Code: RUSCS501

Course Title: ARTIFICIAL INTELLIGENCE
Academic year 2021-22

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION **After Completing this course student will be able to :**
CO 1	Define Artificial Intelligence.
CO 2	Implement various algorithms to solve the real world problems.
CO 3	Use various tools and techniques for automation.
CO 4	Identify different areas for AI implementation.
CO 5	Produce own algorithms.

DETAILED SYLLABUS

Course Code	Unit	ARTIFICIAL INTELLIGENCE	Lectures
RUSCS501	**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.	15 L
	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	15 L
	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.	15 L

Course Code	PRACTICAL OF ARTIFICIAL INTELLIGENCE	Credits
RUSCSP501	1. Implement Breadth first search algorithm for Romanian map problem.	**1**

	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 a 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 problems.	

Reference:

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: RUSCS502

Course Title: SOFTWARE TESTING AND QUALITY ASSURANCE

Academic year 2021-22

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION **After Completing this course student will be able to :**
CO 1	Testing Methods can be used as an effective tools in providing quality assurance concerning for software
CO 2	Skills to design test case plan for testing software

CO 3	Understand various software testing methods and strategies
CO 4	Understand a variety of software metrics, and identify defects and managing those defects
CO 5	Design SQA activities, SQA strategy, formal technical review report for software Quality control and assurance.

DETAILED SYLLABUS

Course Code	Unit	SOFTWARE TESTING AND QUALITY ASSURANCE	Lectures
RUSCS502	**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	15 L
	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.	15 L
	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	15 L

Course Code	PRACTICAL OF SOFTWARE TESTING AND QUALITY ASSURANCE	Credits
RUSCSP502	1. Install Selenium IDE; Write a test suite containing minimum 4 test cases for different formats.	**1**

	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 the 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 checkboxes on the page checked and unchecked count. 10. Load Testing using JMeter, Android Application testing using Appium Tools, Bugzilla Bug tracking tools.	

References:

1. Software Engineering for Students, A Programming Approach, Douglas Bell, 4th Edition,, Pearson Education, 2005
2. Software Engineering - A Practitioner's 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):

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

Course Code: RUSCS503

Course Title: INFORMATION AND NETWORK SECURITY

Academic year 2021-22

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION **After Completing this course student will be able to :**
CO 1	Analyze Particular information and network security Problems

CO 2	Identify generic security threats and Vulnerabilities
CO 3	Assess and Apply various cryptographic techniques
CO 4	Enumerate security Protocols at Network ,Transport and Application Layers of TCP/IP model
CO 5	Implement security solutions for confidentiality, Authentication and privacy.

DETAILED SYLLABUS

Course Code	Unit	INFORMATION AND NETWORK SECURITY	Lectures
RUSCS503	**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	15 L
	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.	15 L
	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	15 L

Course Code	PRACTICAL OF INFORMATION AND NETWORK SECURITY	Credits
RUSCSP503	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 an 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 to 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	**1**

References:

1) Cryptography and Network Security: Principles and Practice 5th Edition, William Stallings, Pearson,2010

Additional Reference(s):

- Cryptography and Network Security, Atul Kahate, Tata McGraw-Hill, 2013.
- Cryptography and Network, Behrouz A Fourouzan, Debdeep Mukhopadhyay, 2nd Edition,TMH,2011

Course Code: RUSCS504

Course Title: WEB SERVICES

Academic year 2021-22

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION **After Completing this course student will be able to :**
CO 1	Understand the details of web services technologies like SOAP, WSDL, and UDDI
CO 2	Identify how to implement and deploy web service clients and servers.
CO 3	Understand the design principles and application of SOAP and REST based web services (JAX-Ws and JAX-RS) Services
CO 4	Evaluate Spring web services and develop spring applications.
CO 5	Understand WCF service to develop secure web services and QoS of Web Services

DETAILED SYLLABUS

Course Code	Unit	WEB SERVICES	Lectures
RUSCS504	**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	15 L
	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	15 L
	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	15 L

Course Code	PRACTICAL OF WEB SERVICES	Credits
RUSCSP504	1. Write a program to implement to create a simple web service that converts the temperature from Fahrenheit to Celsius and vice 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 platforms. 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	**1**

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):

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

Course Code: RUSCS505

Course Title: SKILL ENHANCEMENT: ETHICAL HACKING

Academic year 2021-22

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
	After Completing this course student will be able to :

CO 1	Explain ethics, methodologies of ethical hacking.
CO 2	Identify security vulnerabilities and weaknesses in the target applications.
CO 3	Test and exploit systems using various tools
CO 4	Illustrate different types of attacks and its countermeasure

DETAILED SYLLABUS

Course Code	Unit	SKILL ENHANCEMENT: ETHICAL HACKING	Lectures
RUSCS505	**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.	15 L
	II	**Types of vulnerabilities**: OWASP Top 10 : cross-site scripting (XSS), cross site request forgery (CSRF/XSRF), SQL injection, inp ut 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.	15 L
	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	15 L

		property theft, Vulnerability Assessment and Penetration Testing (VAPT) Process,Instant messenger threats,Evading IDS **Enforcement of security**: Firewall, Secure coding practices, Security policy	

Course Code	PRACTICAL OF SKILL ENHANCEMENT: ETHICAL HACKING	Credits/ Lectures
RUSCSP505	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. 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	**1**

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):

- http://www.pentest-standard.org/index.php/PTES_Technical_Guidelines
- https://www.owasp.org/index.php/Category:OWASP_Top_Ten_2017_Project
- https://www.owasp.org/index.php/Mobile_Top_10_2016-Top_10
- https://www.owasp.org/index.php/OWASP_Testing_Guide_v4_Table_of_Contents
- https://www.owasp.org/index.php/OWASP_Secure_Coding_Practices_-_Quick_Reference_Guide
- https://cve.mitre.org/
- https://access.redhat.com/blogs/766093/posts/2914051
- http://resources.infosecinstitute.com/applications-threat-modeling/#gref
- http://www.vulnerabilityassessment.co.uk/Penetration%20Test.html

Course Code: RUSCSP506

Course Title: PRACTICAL OF ADVANCED WEB PROGRAMMING

Academic year 2021-22

Course Code	PRACTICAL OF ADVANCED WEB PROGRAMMING	Credits
RUSCSP506	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	**1**

MODALITY OF ASSESSMENT

Theory exam total marks: 100 Marks

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
3	Total	40

B) External examination - 60 % : 60 marks

Semester End Theory Examination:

1. Duration - These examinations shall be of **2Hrs** duration.
2. Theory Question Paper Pattern:

All Questions are Compulsory			
Questions	**Options**	**Based On**	**Marks**
Q1	Any 3 out of 4	Unit I, II, & III	15
Q2	Any 3 out of 4	Unit I	15
Q3	Any 3 out of 4	Unit II	15
Q4	Any 3 out of 4	Unit III	15
Total			60

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

Practical exam total marks: 50 Marks

Practical Examination Pattern:

A) Internal Examination: Internal Practical 40% - 20 Marks

10 Marks - Individual Practical Implementation & Performance

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

10 Marks –Design and implement innovative application of the technology

Particulars	**Marks**
Individual Practical Implementation & Performance	10
Design and implement innovative application of the technology	10
Total	20

(B) External (Semester end practical examination): 60% - 30 Marks

30 Marks Practical Questions:

- Students have to acquire at least 40% marks in each paper individually.

Particulars	**Practical**
Laboratory work	30
Total	**30**

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

Overall Examination & Marks Distribution Pattern

Semester V

Course	**501, 502, 503, 504, 505, 506**		
	Internal	**External**	**Total**
Theory	**40**	**60**	**500 (5 Papers)**
Practicals	**20**	**30**	**300 (6 Papers)**
Individual Semester Total			**800**

Course Code: RUSCS601

Course Title: CLOUD COMPUTING

Academic year 2021-22

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION **After Completing this course student will be able to :**
CO 1	Define and describe cloud computing and its architecture.
CO 2	Compare various cloud services available in the cloud.
CO 3	Choose the appropriate cloud services for various types of applications.
CO 4	Explain various of cloud computing such as security, privacy, and interoperability.
CO 5	Express the concepts, key technologies strengths and limitations of cloud computing.

DETAILED SYLLABUS

Course Code	Unit	CLOUD COMPUTING	Lectures
RUSCS601	**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
	II	**Virtualization:** Characteristics of Virtualized Environments. Taxonomy of Vir tualization 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.	15 L
	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 Op enStack in production environments, Building a production environment, Application orchestration using OpenStack Heat.	15 L

Course Code	PRACTICAL OF CLOUD COMPUTING	Credits
RUSCSP601	1. Implementation of Infrastructure as a Service a. VMWare Esxi Server b. Citrix Xenserver 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, Google Cloud & Windows Azure	**1**

References:

1. Mastering Cloud Computing, Rajkumar Buyya, Christian Vecchiola, S Thamarai Selvi, Tata McGraw Hill Education Private Limited, 2013
1. OpenStack in Action, V. K. CODY BUMGARDNER, Manning Publications Co, 2016

Additional Reference(s):

- OpenStack Essentials, Dan Radez, PACKT Publishing, 2015
- OpenStack Operations Guide, Tom Fifield, Diane Fleming, Anne Gentle, Lorin Hochstein, Jonathan Proulx, Everett Toews, and Joe Topjian, O'Reilly Media, Inc., 2014
- https://www.openstack.org

Course Code: RUSCS602

Course Title: CYBER FORENSIC

Academic year 2021-22

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION **After Completing this course student will be able to :**
CO 1	Explain the procedures for identification, preservation, and extraction of electronic evidence
CO 2	Illustrate procedure of network and mobile forensics
CO 3	Analyze legal aspect and Ethics in digital forensics
CO 4	Evaluate real time case study in digital forensics

DETAILED SYLLABUS

Course Code	Unit	CYBER FORENSIC	Lectures
RUSCS602	**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, Sources of Network based Evidence, Sources of log. **Cell Phone and Mobile Device Forensics:** Overview, Acquisition Procedures for Cell Phones and Mobile Devices.	15 L
	II	**Internet Forensic :** Introduction to Internet Forensics, World Wide Web Threats, Hacking and Illegal access, Obscene and Indecent 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	15 L
	III	**Legal aspects and Ethics of Digital Forensics:** Expert Testimony in High-Tech Investigations, Information Technology Act. **Case Study :** Cyber Crime cases	15 L

Course Code	PRACTICAL OF CYBER FORENSIC	Credits
RUSCSP602	**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 restoration.	**1**

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):

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

Course Code: RUSCS603

Course Title: INFORMATION RETRIEVAL

Academic year 2021-22

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION **After Completing this course student will be able to :**
CO 1	Understanding of information retrieval and its relationship to search engines
CO 2	Apply information retrieval models on live dataset.
CO 3	Able to handle issues in classical and web information retrieval
CO 4	Implementation of systems for gathering, indexing, and searching documents and of methods for evaluating systems.

DETAILED SYLLABUS

Course Code	Unit	INFORMATION RETRIEVAL	Lectures
RUSCS603	**I**	**Introduction to Information Retrieval:** Introduction, History of IR, Components of IR, and Issues related to IR, Boolean retrieval, Dictionaries and tolerant retrieval.	15 L
	II	**Link Analysis and Specialized Search:** Link Analysis, hubs and authorities, Pagerank 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, Questi on Answering, Cross- Lingual Retrieval.	15 L
	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.	15 L

Course Code	PRACTICAL ON INFORMATION RETRIEVAL	Credits
RUSCSP603	**Practical may be done using software/tools like Python / Java / Hadoop** 1. Write a program to demonstrate bitwise operation.	**1**

	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 a simple web crawler. 10. Write a program to parse XML text, generate Web graph and compute topic specific page rank.	

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):

- 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: RUSCS604

Course Title: DATA SCIENCE

Academic year 2021-22

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION After Completing this course student will be able to :
CO 1	Develop Analytical solution to Real world data science Problem
CO 2	Apply statistical and mathematical techniques to explore data
CO 3	Compare and Implement various supervised and unsupervised Learning algorithms for specific use cases.
CO 4	Evaluate results of Analytics and suggest Solutions
CO 5	Articulate techniques for handling Time series and Semi-structured data

DETAILED SYLLABUS

Course Code	Unit	DATA SCIENCE	Lectures
RUSCS604	**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	15 L
	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.	15 L
	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	15 L

Course Code	PRACTICAL OF DATA SCIENCE	Credits
RUSCSP604	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	**1**

Reference(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):

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

Course Code: RUSCS605

Course Title: OPTIMIZATION TECHNIQUES

Academic year 2021-22

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION **After Completing this course student will be able to :**
CO 1	Appraise Optimization Techniques on real world problems.
CO 2	Develop optimize solution to given problem
CO 3	Collect information to Implement optimal models for solving real world problems.

DETAILED SYLLABUS

Course Code	Unit	OPTIMIZATION TECHNIQUES	Lectures
RUSCS605	**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	15 L
	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	15 L

	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	15 L

References:

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

Additional Reference(s):

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

Course Code: RUSCSP605
Course Title: PROJECT IMPLEMENTATION

Academic year 2021-22

Course Code	PROJECT IMPLEMENTATION	Credits
RUSCSP605	**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 the head of the department/ project in charge. 3. The Project has to be performed individually. 4. A learner is expected to devote a 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 a BSc course or any other with the prior permission of the 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 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	**2**

	- 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 the 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 background 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/Screenshots/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 a working project and which will be evaluated.	

MODALITY OF ASSESSMENT

Theory exam total marks: 100 Marks

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
3	Total	40

B) External examination - 60 % : 60 marks

Semester End Theory Examination:

1. Duration - These examinations shall be of **2 Hrs** duration.
2. Theory Question Paper Pattern:

All Questions are Compulsory			
Questions	**Options**	**Based On**	**Marks**
Q1	Any 3 out of 4	Unit I, II, & III	15
Q2	Any 3 out of 4	Unit I	15
Q3	Any 3 out of 4	Unit II	15
Q4	Any 3 out of 4	Unit III	15
Total			60

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

Practical exam total marks: 50 Marks

Practical Examination Pattern:

A) Internal Examination: Internal Practical 40% - 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

Particulars	**Marks**
Individual Practical Implementation & Performance	10
Design and implement innovative application of the technology	10
Total	20

(B) External (Semester end practical examination): 60% - 30 Marks

30 Marks Practical Questions:

- Students have to acquire at least 40% marks in each paper individually.

Particulars	**Practical**
Laboratory work	30
Total	**30**

Project Exam total marks: 100 Marks

INTERNAL COMPONENT - 40 Marks

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

Marking Scheme

- Each student has to follow the schedule for above mentioned phases as given by the Project Guide.

- Marks will be allotted on the basis of the presentation made by the student at each stage of project development.
- 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).

Overall Examination & Marks Distribution Pattern

Semester- VI

Course			
	Internal	**External**	**Total**
Theory	**40**	**60**	**500 (5 Papers)**
Practicals	**20**	**30**	**200 (4 Papers)**
Project	**40**	**60**	**100**
Individual Semester Total			**800**