

Karmaveer Bhaurao Patil College, Vashi
Autonomous College
Affiliated to University of Mumbai

Sr. No.	Heading	Particulars
1	Title of Course	Computer Science
2	Eligibility for Admission	SYCS
3	Passing marks	40
4	Ordinances/Regulations (if any)	
5	No. of Semesters	Two
6	Level	U.G.
7	Pattern	Choice Based Credit, Grading and Semester
8	Status	New
9	To be implemented from Academic year	2023-2024

AC- 27/09/2019

Item No- 3.21



**Rayat Shikshan Sanstha's
KARMAVEER BHAURAO PATIL COLLEGE, VASHI.
NAVI MUMBAI
(AUTONOMOUS COLLEGE)
Sector-15- A, Vashi, Navi Mumbai - 400 703**

Syllabus for T.Y.B.Sc. Computer Science

Program: B.Sc. Computer Science

Course: T.Y.B.Sc. Computer Science

**(Choice Based Credit, Grading and Semester System
with effect from the academic year 2023-24)**

Scheme of examination for Each Semester:

Continuous Internal Evaluation: 40 Marks (Common Test-20 Marks & 20 Marks for- Mini Projects, Presentation, Online Course, Case Study, Assignment, Analysis In Statistics, Report Writing, Interviews, Paper Review, Surprise Test).

Semester End Examination: 60 Marks will be as follows-

I.	Theory: The Semester End Examination for theory course work will be conducted as per the following scheme	
	Each theory paper shall be of two and half hour duration.	
	All questions are compulsory and will have internal options.	
	Q – I	From Unit – I (having internal options.) 15 M
	Q – II	From Unit – II (having internal options.)15 M
	Q – III	From Unit – III (having internal options.)15 M
	Q – IV	Questions from all the THREE Units with equal weightage of marks allotted to each Unit. 15 M
II.	Practical	The Semester End Examination for practical course will be conducted as per the following scheme.
Sr. No.	Particulars of Semester End Practical Examination	Marks
1	Laboratory Work	40
2	Journal	05
3	Viva	05
	TOTAL	50

T.Y.B.Sc. Computer Science Syllabus

Choice Based Credit, Grading and Semester System

Academic year 2023-2024

SEMESTER - V

CODE	COURSE TYPE	SUBJECT	SCHEME OF INSTRUCTION		SCHEME OF EXAMINATION			NO. OF CREDITS
			(PERIOD PER WEEK)		(MAX MARKS)			
			TH	LAB	CIA	SEE	TOTAL	
UGCSC501	CORE	Software Testing and Quality Assurance	4	-	40	60	100	4
UGCSCP501	Core Subject Practical	UGCSC501 Practical	-	4	50			2
UGCSC502	CORE	Artificial Intelligence	4	-	40	60	100	4
UGCSCP502	Core Subject Practical	UGCSC502 Practical	-	4	50			2
UGCSDSE503A	Discipline Specific Elective - I	Web Services	4	-	40	60	100	4
UGCSDSEP503A	Discipline Specific Elective - I Practical	UGCSDSE503A Practical	-	4	50			2
UGCSDSE503B	Discipline Specific Elective - I	Linux Server Administration	4	-	40	60	100	4
UGCSDSEP503B	Discipline Specific Elective - I Practical	UGCSDSE503B Practical	-	4	50			2
UGCSDSE504A	Discipline Specific Elective - II	Cyber Forensics	4	-	40	60	100	4
UGCSDSEP504A	Discipline Specific Elective - II Practical	UGCSDSE504A Practical	-	4	50			2
UGCSDSE504B	Discipline Specific Elective - II	Digital Marketing	4	-	40	60	100	4
UGCSDSEP504B	Discipline Specific Elective - II Practical	UGCSDSE504B Practical	-	4	50			2
TOTAL							600	24

SEMESTER – VI

CODE	COURSE TYPE	SUBJECT	SCHEME OF INSTRUCTION		SCHEME OF EXAMINATION			NO. OF CREDITS
			(PERIOD PER WEEK)		(MAX MARKS)			
			TH	LAB	CIA	SEE	TOTAL	
UGCSC601	CORE	Data Science	4	-	40	60	100	4
UGCSCP601	Core Subject Practical	UGCSC501 Practical	-	4	50			2
UGCSC602	CORE	Project Implementation	4	-			100	4
UGCSCP602	Core Subject Practical	Project Documentation	-	4	50			2
UGCSDSE603A	Discipline Specific Elective - I	Ethical Hacking	4	-	40	60	100	4
UGCSDSEP603A	Discipline Specific Elective - I Practical	UGCSDSE603A Practical	-	4	50			2
UGCSDSE603B	Discipline Specific Elective - I	Cloud Computing	4	-	40	60	100	4
UGCSDSEP603B	Discipline Specific Elective - I Practical	UGCSDSE603B Practical	-	4	50			2
UGCSDSE604A	Discipline Specific Elective - II	Digital Image Processing	4	-	40	60	100	4
UGCSDSEP604A	Discipline Specific Elective - II Practical	UGCSDSE604A Practical	-	4	50			2
UGCSDSE604B	Discipline Specific Elective - II	Information Retrieval	4	-	40	60	100	4
UGCSDSEP604B	Discipline Specific Elective - II Practical	UGCSDSE604B Practical	-	4	50			2
TOTAL							600	24

Note: TH-Theory, CIA- Continuous Internal Assessment, SEE-Semester End Exam.

Semester V – Theory

Class: T.Y.B.Sc	Branch: Computer Science	Semester: V	
Subject: Software Testing and Quality Assurance			
Period per Week(Each 48 min)	Lecture	03	
	Practical	03	
Evaluation System		Hours	Marks
	Semester End Exam	2 hr	60
	Continuous Internal Assessment	—	40
	Semester End Practical Examination	3	50
	Total	—	150

Course: UGCSC501	Software Testing and Quality Assurance (Credits : 4 Lectures/Week: 4)	Lectures
	Expected Learning Outcomes: After successful completion of this course, students would be able to: <ol style="list-style-type: none"> 1) Discuss various software testing methods and strategies. 2) Perform various testing techniques. 3) variety of software metrics, and identify defects and managing those defects for improvement in quality for given software. 4) 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	15 L
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.	15 L
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	15 L

	Quality Costs : Defining Quality Costs, Types of Quality Costs, Quality Cost Measurement, Utilizing Quality Costs for Decision-Making	
	<p>Text books:</p> <ol style="list-style-type: none"> 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. <p>Additional References:</p> <ol style="list-style-type: none"> 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 <p>Links:</p> <ol style="list-style-type: none"> 1) http://etaeducation.in/Content/pdf/cs_se.pdf 2) http://www.vssut.ac.in/lecture_notes/lecture1428551142.pdf 	

Sr. No.	Practicals of UGCSC501
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.

Class: T.Y.B.Sc	Branch: Computer Science	Semester: V	
Subject: Artificial Intelligence			
Period per Week(Each 48 min)	Lecture	03	
	Practical	03	
Evaluation System		Hours	Marks
	Semester End Exam	2	60
	Continuous Internal Assessment	—	40
	Semester End Practical Examination	3	50
	Total	—	150

Course: UGCSC50 2	Artificial Intelligence (Credits : 4 Lectures/Week: 4)	Lectures
Expected Learning Outcomes: After successful completion of this course, students would be able to:		
<ol style="list-style-type: none"> 1) Identify systems with Artificial Intelligence. 2) Evaluate Artificial Intelligence capabilities that are beyond conventional technology, for example, 3) chess-playing computers, self-driving cars, robotic vacuum cleaners. 4) Perform Artificial Intelligence techniques for problem solving. 5) Explain the concept of Neural Networks and Learning probabilistic models. 		
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.	15 L
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	15 L
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	15 L

Course: UGCSC50 2	Artificial Intelligence (Credits : 4 Lectures/Week: 4)	Lectures
Expected Learning Outcomes: After successful completion of this course, students would be able to: <ol style="list-style-type: none"> 1) Identify systems with Artificial Intelligence. 2) Evaluate Artificial Intelligence capabilities that are beyond conventional technology, for example, chess-playing computers, self-driving cars, robotic vacuum cleaners. 3) Perform Artificial Intelligence techniques for problem solving. 4) Explain the concept of Neural Networks and Learning probabilistic models. 		
Sr. No.	Practicals of UGCSC502	
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.	
	Note: Practical shall be implemented in LISP	

Class: T.Y.B.Sc	Branch: Computer Science	Semester: V	
Subject: Web Services			
Period per Week(Each 48 min)	Lecture	03	
	Practical	03	
Evaluation System		Hours	Marks

	Semester End Exam	2 hr	60
	Continuous Internal Assessment	—	40
	Semester End Practical Examination	3	50
	Total	—	150

Course: UGCSDSE5 03A	Web Services (Credits : 4 Lectures/Week: 4)	Lectures
	<p>Expected Learning Outcomes: After successful completion of this course, students would be able to:</p> <ol style="list-style-type: none"> 1) Describe structure of SOAP based web services and associated standards such as WSDL. 2) Explain the standardized way or medium to propagate communication between the client and server application. 3) Compare various components of web services and cloud computing over on WCF 4) Analyze the Windows Communication Foundation architecture. 	
Unit I	<p>Web services basics : What Are Web Services? Types of Web Services Distributed computing infrastructure, 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</p>	15 L
Unit II	<p>The REST Architectural style : Introducing HTTP, 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</p>	15 L
Unit III	<p>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 WCF Programming, WCF Feature Details. Web Service QoS</p>	15 L
	<p>Text Book: 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</p> <p>Additional References: 1) Leonard Richardson and Sam Ruby, RESTful Web Services, O'Reilly, 2007</p>	

	2) The Java EE 6Tutorial, Oracle, 2013 Links: 1) https://www.cl.cam.ac.uk/~ib249/teaching/Lecture1_handout.pdf 2) https://www.tutorialspoint.com/wcf/wcf_tutorial.pdf	
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Practical's of UGCSDSE503A	
Sr. No.	
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.

Class: T.Y.B.Sc	Branch: Computer Science	Semester: V	
Subject: Linux Server Administration			
Period per Week(Each 48 min)	Lecture	03	
	Practical	03	
Evaluation System		Hours	Marks

	Semester End Exam	2 hr	60
	Continuous Internal Assessment	—	40
	Semester End Practical Examination	3	50
	Total	—	150

Course: UGCSDSE5 03B	Linux Server Administration (Credits : 4 Lectures/Week: 4)	Lectures
	<p>Expected Learning Outcomes: After successful completion of this course, students would be able to:</p> <ol style="list-style-type: none"> 1) Interpret decisions during the configuration process to create a properly functioning Linux environment. 2) Identify the different uses and advantages of Linux in a business environment in order to participate in discussions regarding network servers and services. 3) Analyse how a Linux server can be integrated within a multi-platform environment. 4) Apply the programs and utilities to administer a Linux machine. 	
Unit I	<p>Introduction: Technical Summary of Linux Distributions, Managing Software</p> <p>Single-Host Administration: Managing Users and Groups, Booting and shutting down processes, File Systems, Core System Services, Process of configuring, compiling, Linux Kernel</p> <p>Networking and Security: TCP/IP for System Administrators, basic network Configuration, Linux Firewall (Netfilter), System and network security</p>	15 L
Unit II	<p>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</p>	15 L
Unit III	<p>Intranet Services: 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.</p>	15 L
	<p>Textbook(s):</p> <ol style="list-style-type: none"> 1) Linux Administration: A Beginner's Guide, Wale Soyinka, Seventh Edition, McGraw-Hill Education, 2016 2) Ubuntu Server Guide, Ubuntu Documentation Team, 2016 <p>Additional Reference(s):</p> <ol style="list-style-type: none"> 1) Mastering Ubuntu Server, Jay LaCroix, PACKT Publisher, 2016 <p>Links:</p> <ol style="list-style-type: none"> 1) https://www.gocit.vn/files/Linux_Administration.A.Beginners.Guide.6th.Edition.www.gocit.vn.pdf 	

	2) https://help.ubuntu.com/lts/serverguide/serverguide.pdf	
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Sr. No.	Practicals of UGCSDSE503B
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.
	Note: Practical shall be performed using any Linux Server (with 8GB RAM). - Internet connection will be required so that Linux server (command line mode) can be connected to Internet.

Class: T.Y.B.Sc		Branch: Computer Science		Semester: VI	
Subject: Cyber Forensics					
Period per Week(Each 48 min)	Lecture	03			
	Practical	03			
Evaluation System				Hours	Marks

	Semester End Exam	2 hr	60
	Continuous Internal Assessment	—	40
	Semester End Practical Examination	3	50
	Total	—	150

Course: UGCSDSE 504A	Cyber Forensics (Credits : 4 Lectures/Week: 4)	Lectures
	<p>Expected Learning Outcomes: After successful completion of this course, students would be able to:</p> <ol style="list-style-type: none"> 1) Interpret and appropriately apply the laws and procedures associated with identifying, acquiring, examining and presenting digital evidence. 2) Recognize the ethical standards of the profession and apply those standards to all aspects of the study and practice of digital forensics. 3) Create the Plans and prepare for all stages of an investigation - detection, initial response and management interaction, investigate various media to collect evidence, reporting 4) Summarize the knowledge of mobile forensics, Social media Forensics, various tools, IT Acts and cyber laws. 	
Unit I	<p>Computer Forensics : Introduction to Computer Forensics and standard procedure, Incident Verification and System Identification ,Recovery of Erased and damaged data, Disk Imaging and Preservation, Data Encryption and Compression, Automated Search Techniques, Forensics Software</p> <p>Network Forensic : Introduction to Network Forensics and tracking network traffic, Reviewing Network Logs, Network Forensics Tools, Performing Live Acquisitions, Order of Volatility, Standard Procedure</p> <p>Cell Phone and Mobile Device Forensics: Overview, Acquisition Procedures for Cell Phones and Mobile Devices</p>	15 L
Unit II	<p>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</p> <p>E-mail Forensics : e-mail analysis, e-mail headers and spoofing, Laws against e-mail Crime, Messenger Forensics: Yahoo Messenger</p> <p>Social Media Forensics: Social Media Investigations</p> <p>Browser Forensics: Cookie Storage and Analysis, Analyzing Cache and temporary internet files, Web browsing activity reconstruction</p>	15 L
Unit III	<p>Investigation, Evidence presentation and Legal aspects of Digital Forensics: Authorization to collect the evidence , Acquisition of Evidence, Authentication of the evidence, Analysis of the evidence, Reporting on the findings, Testimony</p> <p>Introduction to Legal aspects of Digital Forensics: Laws & regulations, Information Technology Act, Giving Evidence in court, Case Study – Cyber Crime cases, Case Study – Cyber Crime cases</p>	15 L

	<p>Textbook(s): Guide to computer forensics and investigations, Bill Nelson, Amelia Philips and Christopher Steuart, course technology, 5th Edition, 2015</p> <p>Additional Reference(s): Incident Response and computer forensics, Kevin Mandia, Chris Prosise, Tata McGrawHill, 2nd Edition, 2003</p> <p>Links: ://ebook.eqbal.ac.ir/Security/Forensics/Guide%20to%20Computer%20Forensics%20and%20Investigations.pdf ://www.antoanthongtin.vn/Portals/0/UploadImages/kiennt2sach-CSDL4/Baomatdientoan/McGraw.Hill.Incident.Response%20Computer.Forensics.Second.Edition.eBook-KB.pdf</p>	
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Sr.No.	Practicals of UGCSDSE504A
1	Creating a Forensic Image using FTK Imager/Encase Imager : - Creating Forensic Image - Check Integrity of Data - Analyze Forensic Image
2	Data Acquisition: - Perform data acquisition using: - USB Write Blocker + Encase Imager - SATA Write Blocker + Encase Imager - Falcon Imaging Device
3	Forensics Case Study: - Solve the Case study (image file) provide in lab using Encase Investigator or Autopsy
4	Capturing and analyzing network packets using Wireshark (Fundamentals) : - Identification the live network - Capture Packets - Analyze the captured packets
5	Analyze the packets provided in lab and solve the questions using Wireshark : - What web server software is used by www.snopes.com? - About what cell phone problem is the client concerned? - According to Zillow, what instrument will Ryan learn to play? - How many web servers are running Apache? - What hosts (IP addresses) think that jokes are more entertaining when they are explained?
6	Using Sysinternals tools for Network Tracking and Process Monitoring : - Check Sysinternals tools Monitor Live Processes - Capture RAM - Capture TCP/UDP packets - Monitor Hard Disk - Monitor Virtual Memory - Monitor Cache Memory
7	Recovering and Inspecting deleted files - Check for Deleted Files - Recover the Deleted Files - Analyzing and Inspecting the recovered files

	Perform this using recovery option in ENCASE and also Perform manually through command line
8	Acquisition of Cell phones and Mobile devices
9	Email Forensics - Mail Service Providers - Email protocols - Recovering emails - Analyzing email header
10	Web Browser Forensics - Web Browser working - Forensics activities on browser - Cache / Cookies analysis - Last Internet activity

Class: T.Y.B.Sc		Branch: Computer Science		Semester: V	
Subject: Digital Marketing					
Period per Week(Each 48 min)	Lecture			03	
	Practical			03	
Evaluation System			Hours	Marks	
	Semester End Exam		2 hr	60	
	Continuous Internal Assessment		—	40	
	Semester End Practical Examination		3	50	
	Total		—	150	

Course: UGCSDSE5 04B	Digital Marketing (Credits : 4 Lectures/Week: 4)	Lectures
	Expected Learning Outcomes: After successful completion of this course, students would be able to: 1)	
Unit I	An introduction to Internet marketing Introduction – how significant is the Internet for marketing?, What is Internet marketing?, What benefits does the Internet provide for the marketer?, A strategic approach to Internet marketing, How do Internet marketing communications differ from., traditional marketing communications?, A short introduction to Internet technology, The Internet micro-environment, Marketplace, Customers, Online buyer behaviour, Competitors, Suppliers, Intermediaries, The Internet macro-environment, Social factors, Legal and ethical issues of Internet usage, Technological factors, Economic factors, Political factors	15 L
Unit II	Internet marketing strategy: An integrated Internet marketing strategy, A generic strategic approach, Situation review, Strategic goal setting, Strategy formulation Strategy implementation, The Internet and the marketing mix, Product, Price, Place, Promotion, People, process and physical evidence, Relationship marketing using the Internet, Key concepts of relationship marketing, Key concepts of electronic customer	15 L

	relationship management, (e-CRM), Customer lifecycle management, Approaches to implementing e-CRM	
Unit III	<p>Delivering the online customer experience: Planning web site design and build</p> <ul style="list-style-type: none"> ► Initiation of the web site project, Researching site users' requirements <p>Designing the user experience, Development and testing of content, Promotion of the web site, Service quality, Interactive marketing communications, The characteristics of interactive marketing communications, Integrated Internet marketing communications, Objectives and measurement for interactive marketing communications, Offline promotion techniques,</p> <p>Online promotion techniques, Search engine marketing, Online PR, Online partnership marketing, Interactive advertising, E-mail marketing, Viral marketing, On-site promotional techniques</p> <p>Maintaining and monitoring the online presence: Performance management for Internet marketing, The maintenance process, Responsibilities in web site maintenance,</p> <p>Business-to-consumer Internet marketing, Online customers, E-retailing, Online retail activities, Implications for e-retail marketing strategy, Business-to-business Internet marketing, B2B e-context, Commercial exchanges in B2B markets, Trading relationships in B2B markets, Digital marketing strategies</p>	15 L
	<p>Text books: Internet Marketing Strategy, Implementation and Practice 3rd Edition Dave Chaffey, Fiona Ellis-Chadwick, Richard Mayer and Kevin Johnston</p> <p>Additional References: 1) BIG BOOK OF DIGITAL MARKETING Ignition One Marketing Technologies Volume 1</p>	

Sr. No.	Practicals of UGCSDSE504B
	10 Practical covering topics from syllabus

Class: T.Y.B.Sc	Branch: Computer Science		Semester: VI	
Subject: Data Science				
Period per Week(Each 48 min)	Lecture	03		
	Practical	—		
Evaluation System		Hours	Marks	
	Semester End Exam	2 hr	60	
	Continuous Internal Assessment	—	40	
	Semester End Practical Examination	—	—	
	Total	—	100	

Course: UGCSC601	Data Science (Credits : 3 Lectures/Week: 3)	Lectures
	Expected Learning Outcome: After successful completion of this course, students would be able to: <ol style="list-style-type: none"> 1) Recognize how to obtain, clean/process and transform data. 2) Analyze and interpret data using an ethically responsible approach. 3) Choose appropriate models of analysis, assess the quality of input, derive insight from results, and investigate potential issues. 4) Apply computing theory, languages and algorithms, as well as mathematical and statistical models, and the principles of optimization to appropriately formulate and use data analyses. 5) Summarize various packages in R software 	
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, z 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
Text books: <ol style="list-style-type: none"> 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 references: <ol style="list-style-type: none"> 1) Hands-On Programming with R, Garrett Golemund,1st Edition, 2014 2) An Introduction to Statistical Learning, James, G., Witten, D., Hastie, T., Tibshirani, R.,Springer,2015 Links: <ol style="list-style-type: none"> 1) https://share.nxtcloud.net/mirror/New/Data%20Science%20presented%20by%20O%27Reilly/Doing%20Data%20Science%20-%20Straight%20Talk%20from%20the%20Frontline.pdf 		

Sr.No	Practicals of UGCSC601
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
9.	Practical of Analysis of Variance
10.	Practical of Decision Tree
	Note:Practical shall be performed using R

Course: UGCSC602	Project Implementation (Credits : 01 Lectures/Week: 03)
Project Implementation Guidelines	
<ol style="list-style-type: none"> 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 <ol style="list-style-type: none"> 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

****Project Evaluation Scheme:**

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

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

Class: T.Y.B.Sc	Branch: Computer Science	Semester: VI
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Subject: Ethical Hacking			
Period per Week(Each 48 min)	Lecture	03	
	Practical	03	
Evaluation System		Hours	Marks
	Semester End Exam	2 hr	60
	Continuous Internal Assessment	—	40
	Semester End Practical Examination	3	50
	Total	—	150

Course: UGCSDSE60 3A	Ethical Hacking (Credits : 3 Lectures/Week: 3)	Lectures
	<p>Expected Learning Outcomes: After successful completion of this course, students would be able to:</p> <ol style="list-style-type: none"> 1) Describe various Vulnerabilities on Websites and define information Security 2) Evaluate Penetration Testing and Vulnerability Assessment. 3) Conclude and discuss about real scenario on types of attacks 4) Analyze the various Malware types with security mechanism 	
Unit I	<p>Information Security : Attacks and Vulnerabilities Introduction to information security : Asset, Access Control, CIA, Authentication, Authorization, Risk, Threat, Vulnerability, Attack, Attack Surface, Malware, Security-Functionality-Ease of Use Triangle Types of malware : Worms, viruses, Trojans, Spyware, Rootkits 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 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 Case-studies : Recent attacks – Yahoo, Adult Friend Finder, eBay, Equifax, WannaCry, Target Stores, Uber, JP Morgan Chase, Bad Rabbit</p>	15L
Unit II	<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. Approach : Planning - Threat Modeling, set up security verification standards, Set up security testing plan – When, which systems/apps, understanding functionality,</p>	15L

	<p>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>	
Unit III	<p>Ethical Hacking :Enterprise Security 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 techniques, Secure Code Reviews (Fortify tool, OWASP Secure Coding Guidelines)</p>	15L

Text Book(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>

Links:

- 1) <https://www.guru99.com/ethical-hacking-tutorials.html>

Sr.No.	Practicals of UGCSDSE603A
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 Nemesys 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)

Class: T.Y.B.Sc		Branch: Computer Science		Semester: VI	
Subject: Cloud Computing					
Period per Week(Each 48 min)	Lecture	03			
	Practical	03			
Evaluation System		Hours	Marks		
	Semester End Exam	2 hr	60		
	Continuous Internal Assessment	—	40		
	Semester End Practical Examination	3	50		
	Total	—	150		

Course: UGCSDSE6 03B	Cloud Computing (Credits : 3 Lectures/Week: 3)	Lectures
	Expected Learning Outcomes: After successful completion of this course, students would be able to: <ol style="list-style-type: none"> 1) Define the concept of Cloud Computing and Compare cloud computing with distributed computing. 2) Identify the architecture and infrastructure of cloud computing, including SaaS, PaaS, IaaS, public cloud, private cloud, hybrid cloud, etc. 3) Describe the characteristics of Virtualized Environments, Virtualization using KVM. 4) Explain the concept of OpenStack in cloud computing. 	
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	15 L
Unit III	Introduction to OpenStack, 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 orchestration using OpenStack Heat	15 L
	<p>Textbook(s):</p> <ol style="list-style-type: none"> 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. <p>Additional Reference(s):</p> <ol style="list-style-type: none"> 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 <p>Links:</p> <ol style="list-style-type: none"> 1) https://www.tutorialspoint.com/cloud_computing/cloud_computing_tutorial.pdf 2) https://ramslaw.files.wordpress.com/2016/07/0124114547cloud.pdf 	

Sr.No	Practicals of UGCSDSE603B	
1	Study of Cloud Computing & Architecture.	
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	

Class: T.Y.B.Sc	Branch: Computer Science	Semester: VI	
Subject: Digital Image Processing			
Period per Week(Each 48 min)	Lecture	03	
	Practical	03	
Evaluation System		Hours	Marks
	Semester End Exam	2 hr	60
	Continuous Internal Assessment	—	40
	Semester End Practical Examination	3	50
	Total	—	150

Course: UGCSDSE604 A	Digital Image Processing (Credits : 3Lectures/Week: 3)	Lectures
	<p>Expected Learning Outcomes: After successful completion of this course, students would be able to:</p> <ol style="list-style-type: none"> 1) Explain the fundamental concepts of a digital image processing system. 2) Analyze the images in the frequency domain and spatial domain using various transforms and . 3) Describe and analyze how digital images are represented,manipulated, encoded and processed, compressed with emphasis on algorithm design, implementation and performance evaluation. 4) Evaluate the concepts of convolution and correlation using various methods. 	
Unit I	<p>Introduction to Image-processing System : Introduction, Image Sampling, Quantization, Resolution, Human Visual Systems, Elements of an Image-processing System, Applications of Digital Image Processing</p> <p>2D Signals and Systems : 2D signals, separable sequence, periodic sequence, 2D systems, classification of 2D systems, 2D Digital filter</p> <p>Convolution and Correlation : 2D Convolution through graphical method, Convolution through 2D Z—transform, 2D Convolution through matrix analysis, Circular Convolution, Applications of Circular Convolution, 2D Correlation</p> <p>Image Transforms: Need for transform, image transforms, Fourier transform, 2D Discrete Fourier Transform, Properties of 2D DFT, Importance of Phase, Walsh transform, Hadamard transform, Haar transform, Slant transform, Discrete Cosine transform, KL transform</p>	15 L
Unit II	<p>Image Enhancement :Image Enhancement in spatial domain, Enhancement trough Point operations, Histogram manipulation, Linear and nonlinear Gray Level Transformation, local or neighborhood operation, Median Filter, Spatial domain High pass filtering, Bit-plane slicing, Image Enhancement in frequency domain, Homomorphic filter, Zooming operation, Image Arithmetic</p> <p>Binary Image processing :Mathematical morphology, Structuring elements, Morphological image processing, Logical operations, Morphological operations, Dilation and Erosion, Distance Transform</p>	15 L

	Colour Image processing :Colour images, Colour Model, Colour image quantization, Histogram of a colour image	
Unit III	Image Segmentation: Image segmentation techniques, Region approach, Clustering techniques, Thresholding, Edge-based segmentation, Edge detection, Edge Linking, Hough Transform Image Compression: Need for image compression, Redundancy in images, Image-compression scheme, Fundamentals of Information Theory, Run-length coding, Shannon-Fano coding, Huffman Coding, Arithmetic Coding, Transform-based compression, Image-compression standard	15 L
	TextBook: 1) Digital Image Processing, S Jayaraman, S Esakkirajan, T Veerakumar, Tata McGraw-Hill Education Pvt. Ltd., 2009 Additional Reference: 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 Links: 1) https://scilab.in/textbook_companion/generate_book/125	

Sr.No.	Practicals of UGCS DSE604A
1	2D Linear Convolution, Circular Convolution between two 2D matrices
2	Circular Convolution expressed as linear convolution plus alias
3	Linear Cross correlation of a 2D matrix, Circular correlation between two signals and Linear auto correlation of a 2D matrix, Linear Cross correlation of a 2D matrix
4	DFT of 4x4 gray scale image
5	Compute discrete cosine transform, Program to perform KL transform for the given 2D matrix
6	Brightness enhancement of an image, Contrast Manipulation, image negative
7	Perform threshold operation, perform gray level slicing without background
8	Image Segmentation
9	Image Compression
10	Binary Image Processing and Colour Image processing
	Note: Practical need to be performed using Scilab under Linux or Windows

Class: T.Y.B.Sc	Branch: Computer Science	Semester: VI
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Subject: Information Retrieval			
Period per Week(Each 48 min)	Lecture	03	
	Practical	03	
Evaluation System		Hours	Marks
	Semester End Exam	2 hr	60
	Continuous Internal Assessment	—	40
	Semester End Practical Examination	3	50
	Total	—	150

Course: UGCSDSE6 04B	Information Retrieval (Credits : 3 Lectures/Week: 3)	Lectures
	Expected Learning Outcomes: After successful completion of this course, students would be able to: 1) Identify Database Management systems and data warehouses 2) Explain the field of information retrieval and its relationship to search engines. 3) Compare the Text-centric versus data-centric XML retrieval. 4) Illustrate the concept of Web Search Algorithm.	
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 & Map Reduce, 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
Textbook:		
<ol style="list-style-type: none"> 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 references:		
<ol style="list-style-type: none"> 4) 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) 		
Links:		

1) <http://www.math.unipd.it/~aiolli/corsi/0910/IR/irbookprint.pdf>

Sr.No	Practicals of UGCSDSE604B
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.
	Note:Practical may be done using software/tools like Python / Java / Hadoop