Devrukh Shikshan Prasarak Mandal's

Nya. TATYASAHEB ATHALYE ARTS, Ved. S.R. SAPRE COMMERCE & Vid. DADASAHEB PITRE SCIENCE COLLEGE, DEVRUKH [AUTONOMOUS]

Syllabus for T. Y. B. Sc.
Program: B. Sc.
Course: Computer Science
Credit Based Semester and Grading System with the Effect from
Academic Year 2021-22

Preamble

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

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

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

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

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

B. Sc. Computer Science (Semester Pattern) B. Sc. Third Year

COMPUTER SCIENCE– CURRICULUM

COURSE CODE	COURSE TITLE	CREDITS	LECTURE / WEEK
SEMESTER V			
	Elective-I (Select Any Two)		
USCST51	Artificial Intelligence	3	3
USCST52	Linux Server Administration	3	3
USCST53	Software Testing and Quality Assurance	3	3
	Elective-II (Select Any Two)		
USCST54	Information and Network Security	3	3
USCST55	Architecting of IoT	3	3
USCST56	Web Services	3	3
	Skill Enhancement		
USCST57	Game Programming	2	3
	Practical		
USCSP58	Practical of Elective-I	2	6
USCSP59	Practical of Elective-II	2	6
USCSP5X	Project Implementation	1	3
USCSP50	Practical of Skill Enhancement	1	3

COURSE CODE	COURSE TITLE	CREDITS	LECTURE / WEEK
SEMESTER VI			
	Elective-I (Select Any Two)		
USCST61	Wireless Sensor Networks and Mobile Communication	3	3
USCST62	Cloud Computing	3	3
USCST63	Cyber Forensics	3	3
	Elective-II (Select Any Two)		
USCST64	Information Retrieval	3	3
USCST65	Digital Image Processing	3	3
USCST66	Data Science	3	3
	Skill Enhancement		
USCST67	Ethical Hacking	2	3
	Practical		
USCSP68	Practical of Elective-I	2	6
USCSP69	Practical of Elective-II	2	6
USCSP6X	Project Implementation	1	3
USCSP60	Practical of Skill Enhancement	1	3

Semester V – Theory

Course: USCST51	Artificial Intelligence (Credits : 3, Lectures/Week: 3)	
Objectives: Artificial Intelligence (AI) and accompanying tools and techniques bring transformational changes in the world. Machines capability to match, and sometimes even surpass human capability, make AI a hot topic in Computer Science. This course aims to introduce the learner to this interesting area.		
Learning Outcomes: After completion of this course, learner should get a clear understanding of AI and different search algorithms used for solving problems. The learner should also get acquainted with different learning algorithms and models used in machine learning.		
Unit I	**What Is AI:** Foundations, History and State of the Art of AI. **Intelligent Agents:** Agents and Environments, Nature of Environments, **Structure of Agents.** **Problem Solving by searching:** Problem-Solving Agents, Example Problems, Searching for Solutions, Uninformed Search Strategies, Informed (Heuristic) Search Strategies, Heuristic Functions.	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
Reference book: • Artificial Intelligence: A Modern Approach, Stuart Russell and Peter Norvig, 3rd Edition, Pearson, 2010. **Text book:** • Techmax publication book		

Additional References:
- Artificial Intelligence: Foundations of Computational Agents, David L Poole,Alan K. Mackworth, 2nd Edition, Cambridge University Press ,2017.
- Artificial Intelligence, Kevin Knight and Elaine Rich, 3rd Edition, 2017
- The Elements of Statistical Learning, Trevor Hastie, Robert Tibshirani and Jerome Friedman,Springer, 2013

Semester V – Practical

Course: USCSP58	Practical of USCST51 (Credits : 1, Lectures/Week: 3)
USCSP58	Practical shall be implemented in LISP or python 1. Implement Breadth first search algorithm for Romanian map problem. 2. Implement Iterative deep depth first search for Romanian map problem. 3. Implement A* search algorithm for Romanian map problem. 4. Implement recursive best-first search algorithm for Romanian map problem. 5. Implement decision tree learning algorithm for the restaurant waiting problem. 6. Implement feed forward back propagation neural network learning algorithm for the restaurant waiting problem. 7. Implement Adaboost ensemble learning algorithm for the restaurant waiting problem. 8. Implement Naive Bayes' learning algorithm for the restaurant waiting problem. 9. Implement passive reinforcement learning algorithm based on adaptive dynamic programming (ADP) for the 3 by 4 world problem 10. Implement passive reinforcement learning algorithm based on temporal differences (TD) for 3 by 4 world problem

Semester V – Theory

Course: USCST52	Linux Server Administration (Credits : 3, Lectures/Week: 3)	
Objectives: Demonstrate proficiency with the Linux command line interface, directory & file management techniques, file system organization, and tools commonly found on most Linux distributions. Effectively operate a Linux system inside of a network environment to integrate with existing service solutions. Demonstrate the ability to troubleshoot challenging technical problems typically encountered when operating and administering Linux systems. **Learning Outcomes:** Learner will be able to develop Linux based systems and maintain. Learner will be able to install appropriate service on Linux server as per requirement. Learner will have proficiency in Linux server administration.		
Unit I	**Introduction:** Technical Summary of Linux Distributions, Managing Software **Single-Host Administration:** Managing Users and Groups, Booting and shutting down processes, File Systems, Core System Services, Process of configuring, compiling, Linux Kernel **Networking and Security:** TCP/IP for System Administrators, basic network Configuration, Linux Firewall (Netfilter), System and network security	15 L
Unit II	**Internet Services:** Domain Name System (DNS), File Transfer Protocol (FTP), Apache web server, Simple Mail Transfer Protocol (SMTP), Post Office Protocol and Internet Mail Access Protocol (POP and IMAP), Secure Shell (SSH), Network Authentication, OpenLDAP Server, Samba and LDAP, Network authentication system (Kerberos), Domain Name Service (DNS), Security	15 L
Unit III	**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	15 L
Reference book: • Linux Administration: A Beginner's Guide, Wale Soyinka, Seventh Edition, McGraw-Hill Education, 2016		

- Ubuntu Server Guide, Ubuntu Documentation Team, 2016

Text book:
- Techmax publication book

Additional References:
- Mastering Ubuntu Server, Jay LaCroix, PACKT Publisher, 2016

Semester V – Practical

Course: USCSP58	Practical of USCST52 (Credits : 1, Lectures/Week: 3)
USCSP58	*- Practical shall be performed using any Linux Server (with 8 or 16 GB RAM).* *- Internet connection will be required so that Linux server (command line mode) can be connected to Internet.* 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.

Semester V – Theory

Course: USCST53	Software Testing and Quality Assurance (Credits : 3, Lectures/Week: 3)	
Objectives: To provide learner with knowledge in Software Testing techniques. To understand how testing methods can be used as an effective tools in providing quality assurance concerning for software. To provide skills to design test case plan for testing software. **Learning Outcomes:** Understand various software testing methods and strategies. Understand a variety of software metrics, and identify defects and managing those defects for improvement in quality for given software. Design SQA activities, SQA strategy, formal technical review report for software quality control and assurance.		
Unit I	**Software Testing and Introduction to quality :** Introduction, Nature of errors, an example for Testing, Definition of Quality , QA, QC, QM and SQA , Software Development Life Cycle, Software Quality Factors **Verification and Validation :** Definition of V &V , Different types of V & V Mechanisms, Concepts of Software Reviews, Inspection and Walkthrough **Software Testing Techniques :** Testing Fundamentals, Test Case Design, White Box Testing and its types, Black Box Testing and its types	**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 **Quality Costs :** Defining Quality Costs, Types of Quality Costs,	**15 L**

	Quality Cost Measurement, Utilizing Quality Costs for Decision-Making	

Reference book:
- Software Engineering for Students, A Programming Approach, Douglas Bell, 4th Edition,, Pearson Education, 2005
- Software Engineering – A Practitioners Approach, Roger S. Pressman, 5th Edition, Tata McGraw Hill, 2001
- Quality Management, Donna C. S. Summers, 5th Edition, Prentice-Hall, 2010.
- Total Quality Management, Dale H. Besterfield, 3rd Edition, Prentice Hall, 2003.

Text book:
- Techmax publication book

Additional References:
- 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

Semester V – Practical

Course: USCSP58	Practical of USCST53 (Credits : 1, Lectures/Week: 3)
USCSP58	1. Install Selenium IDE; Write a test suite containing minimum 4 test cases for different formats. 2. Conduct a test suite for any two web sites. 3. Install Selenium server (Selenium RC) and demonstrate it using a script in Java/PHP. 4. Write and test a program to login a specific web page. 5. Write and test a program to update 10 student records into table into Excel file 6. Write and test a program to select the number of students who have scored more than 60 in any one subject (or all subjects). 7. Write and test a program to provide total number of objects present / available on the page. 8. Write and test a program to get the number of items in a list / combo box.

	9. Write and test a program to count the number of check boxes on the page checked and unchecked count.
	10. Load Testing using JMeter, Android Application testing using Appium Tools, Bugzilla Bug tracking tools.

Semester V – Theory

Course: USCST54	Information and Network Security (Credits : 3, Lectures/Week: 3)	
Objectives: To provide students with knowledge of basic concepts of computer security including network security and cryptography. **Learning Outcomes:** Understand the principles and practices of cryptographic techniques. Understand a variety of generic security threats and vulnerabilities, and identify & analyze particular security problems for a given application. Understand various protocols for network security to protect against the threats in a network.		
Unit I	**Introduction:** Security Trends, The OSI Security Architecture, Security Attacks, Security Services, Security Mechanisms **Classical Encryption Techniques:** Symmetric Cipher Model, Substitution Techniques, Transposition Techniques, Steganography, Block Cipher Principles, The Data Encryption Standard, The Strength of DES, AES (round details not expected), Multiple Encryption and Triple DES, Block Cipher Modes of Operation, Stream Ciphers **Public-Key Cryptography and RSA:** Principles of Public-Key Cryptosystems, The RSA Algorithm	**15 L**
Unit II	**Key Management:** Public-Key Cryptosystems, Key Management, Diffie-Hellman Key Exchange **Message Authentication and Hash Functions**: Authentication Requirements, Authentication Functions, Message Authentication Codes, Hash Functions, Security of Hash Functions and Macs, Secure Hash Algorithm, HMAC **Digital Signatures and Authentication:** Digital Signatures, Authentication Protocols, Digital Signature Standard **Authentication Applications:** Kerberos, X.509 Authentication, Public-Key Infrastructure.	**15 L**
Unit III	**Electronic Mail Security:** Pretty Good Privacy, S/MIME **IP Security:** Overview, Architecture, Authentication Header, Encapsulating Security Payload, Combining Security Associations, Key Management **Web Security:** Web Security Considerations, Secure Socket Layer and Transport Layer Security, Secure Electronic Transaction **Intrusion:** Intruders, Intrusion Techniques, Intrusion Detection	**15 L**

	Malicious Software: Viruses and Related Threats, Virus Countermeasures, DDOS Firewalls: Firewall Design Principles, Types of Firewalls	
Reference book: • Cryptography and Network Security: Principles and Practice 5th Edition, William Stallings, Pearson,2010 **Text book:** • Techmax publication book **Additional References:** • Cryptography and Network Security, Atul Kahate, Tata McGraw-Hill, 2013. • Cryptography and Network, Behrouz A Fourouzan, Debdeep Mukhopadhyay, 2nd Edition,TMH,2011		

Semester V – Practical

Course: USCSP59	Practical of USCST54 (Credits : 1, Lectures/Week: 3)

USCSP59	1.Write programs to implement the following Substitution Cipher Techniques:
	       - Caesar Cipher
	       - Monoalphabetic Cipher
	2 Write programs to implement the following Substitution Cipher Techniques:
	       - Vernam Cipher
	       - Playfair Cipher
	3 Write programs to implement the following Transposition Cipher Techniques:
	       - Rail Fence Cipher
	       - Simple Columnar Technique
	4 Write program to encrypt and decrypt strings using
	       - DES Algorithm
	       - AES Algorithm
	5 Write a program to implement RSA algorithm to perform encryption / decryption of a given string.
	6 Write a program to implement the Diffie-Hellman Key Agreement algorithm to generate symmetric keys.
	7 Write a program to implement the MD5 algorithm compute the message digests.
	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	

Semester V – Theory

Course: USCST55	Architecting of IoT (Credits : 3, Lectures/Week: 3)	
Objectives: Discovering the interconnection and integration of the physical world. Learner should get knowledge of the architecture of IoT. **Learning Outcomes:** Learners are able to design & develop IoT Devices. They should also be aware of the evolving world of M2M Communications and IoT analytics.		
Unit I	**IoT-An Architectural Overview**: Building architecture, Main design principles and needed capabilities, An IoT architecture outline, standards considerations. **IoT Architecture-State of the Art** : Introduction, State of the art, Reference Model and architecture, IoT reference Model - IoT Reference Architecture Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views.	15 L
Unit II	**IoT Data Link Layer and Network Layer Protocols:** PHY/MAC Layer(3GPP MTC, IEEE 802.11, IEEE 802.15), Wireless HART,Z-Wave, Bluetooth Low Energy, Zigbee Smart Energy DASH7 **Network Layer**:IPv4, IPv6, 6LoWPAN, 6TiSCH,ND, DHCP, ICMP, RPL, CORPL, CARP	15 L
Unit III	**Transport layer protocols :** Transport Layer (TCP, MPTCP, UDP, DCCP, SCTP)-(TLS, DTLS) **Session layer:** Session Layer-HTTP, CoAP, XMPP, AMQP, MQTT **Service layer protocols:** Service Layer -oneM2M, ETSI M2M, OMA, BBF	15 L
Reference book: • From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence, Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle,1st Edition, Academic Press, 2014. • Learning Internet of Things, Peter Waher, PACKT publishing, BIRMINGHAM – MUMBAI,2015 **Text book:** • Techmax publication book		

Additional References:

- Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications, Daniel Minoli, Wiley Publications,2013
- Internet of Things (A Hands-onApproach), Vijay Madisetti and Arshdeep Bahga, 1st Edition, VPT, 2014.
- http://www.cse.wustl.edu/~jain/cse570-15/ftp/iot_prot/index.html

Semester V – Practical

Course: USCSP59	Practical of USCST55 (Credits : 1, Lectures/Week: 3)
USCSP59	1. a) Edit text files with nano and cat editor, Learn sudo privileges and Unix shell commands such as cd , ls , cat, etc b) Learn to set dynamic and static IP. Connect to and Ethernet and WiFi network. Learn to vnc and ssh into a raspberry pi using vnc and putty from a different computer on the network. c) Write a basic bash script to open programs in kiosk mode. Learn how to autostart programs on boot. 2. Run the node red editor and run simple programs and trigger gpios. Use basic nodes such as inject, debug, gpio 3. Open the python idle editor and run simple Python scripts such as to print Fibonacci numbers, string functions. Learn how to install modules using Pip and write functions 4. Setup a physical button switch and trigger an led in node red and python w debounce 5. Write simple JavaScript functions in Node-Red simple HTTP server page using node red 6. Setup a TCP server and client on a raspberry pi using Python modules to send messages and execute shell commands from within python such as starting another application 7. Trigger a set of led Gpios on the pi via a Python Flask web server 8. Interface the raspberry pi with a 16x2 LCD display and print values. 9. Setup a Mosquitto MQTT server and client and write a Python script to communicate data between Pi's. 10. Interface with an Accelerometer Gyro Mpu6050 on the i2c bus and send sensor values over the internet via mqtt.

Semester V – Theory

Course: USCST56	Web Services (Credits : 3, Lectures/Week: 3)	
Objectives: To understand the details of web services technologies like SOAP, WSDL, and UDDI. To learn how to implement and deploy web service client and server. To understand the design principles and application of SOAP and REST based web services (JAX-Ws and JAX-RS).To understand WCF service. To design secure web services and QoS of Web Services. **Learning Outcomes:** Emphasis on SOAP based web services and associated standards such as WSDL. Design SOAP based / RESTful / WCF services Deal with Security and QoS issues of Web Services.		
Unit I	**Web services basics :** What Are Web Services? Types of Web Services Distributed computing infrastructure, 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.	**15 L**
Unit II	**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.	**15 L**
Unit III	**Developing Service-Oriented Applications with WCF :** What Is Windows Communication Foundation, Fundamental Windows Communication Foundation Concepts, Windows Communication Foundation Architecture, WCF and .NET Framework Client Profile, Basic WCF Programming, WCF Feature Details. Web Service QoS	**15 L**
Reference book: - Web Services: Principles and Technology, Michael P. Papazoglou, Pearson Education Limited, 2008 - RESTful Java Web Services, Jobinesh Purushothaman, PACKT Publishing,2nd Edition, 2015 - Developing Service-Oriented Applications with WCF, Microsoft,		

2017 https://docs.microsoft.com/en-us/dotnet/framework/wcf/index

Text book:
- Techmax publication book

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

Semester V – Practical

Course: USCSP59	Practical of USCST56 (Credits : 1, Lectures/Week: 3)
USCSP59	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.

Semester V – Theory

Course: USCST57	Game Programming (Credits : 3, Lectures/Week: 3)	
Objectives: Learner should get the understanding computer Graphics programming using Directx or Opengl. Along with the VR and AR they should also aware of GPU, newer technologies and programming using most important API for windows. **Learning Outcomes:** Learner should study Graphics and gamming concepts with present working style of developers where everything remains on internet and they need to review it, understand it, be a part of community and learn.		
Unit I	**Mathematics for Computer Graphics, DirectX Kickstart:** **Cartesian Coordinate system:** The Cartesian XY-plane, Function Graphs, Geometric Shapes, Polygonal Shapes, Areas of Shapes, Theorem of Pythagoras in 2D, Coordinates, Theorem of Pythagoras in 3D, 3D Polygons, Euler's Rule **Vectors:** Vector Manipulation, multiplying a Vector by a Scalar, Vector Addition and Subtraction, Position Vectors, Unit Vectors, Cartesian Vectors, Vector Multiplication, Scalar Product, Example of the Dot Product, The Dot Product in Lighting Calculations, The Dot Product in Back-Face Detection, The Vector Product, The Right-Hand Rule, deriving a Unit Normal Vector for a Triangle Areas, Calculating 2D Areas **Transformations:** 2D Transformations, Matrices, Homogeneous Coordinates,3D Transformations, Change of Axes, Direction Cosines, rotating a Point about an Arbitrary Axis, Transforming Vectors, Determinants, Perspective Projection, Interpolation **DirectX:** Understanding GPU and GPU architectures. How they are different from CPU Architectures? Understanding how to solve by GPU?	**15 L**
Unit II	**DirectX Pipeline and Programming:** **Introduction To DirectX 11:** COM, Textures and Resources Formats, The swap chain and Page flipping, Depth Buffering, Texture Resource Views, Multisampling Theory and MS in Direct3D, Feature Levels **Direct3D 11 Rendering Pipeline:** Overview, Input Assembler Stage (IA), Vertex Shader Stage (VS), The Tessellation Stage (TS), Geometry Shader Stage (GS), Pixel Shader Stage (PS), Output merger Stage (OM) Understanding Meshes or Objects,	**15 L**

	Texturing, Lighting, Blending. **Interpolation and Character Animation:** **Trigonometry:** The Trigonometric Ratios, Inverse Trigonometric Ratios, Trigonometric Relationships, The Sine Rule, The Cosine Rule, Compound Angles, Perimeter Relationships **Interpolation**: Linear Interpolant, Non-Linear Interpolation, Trigonometric Interpolation, Cubic Interpolation, Interpolating Vectors, Interpolating Quaternions **Curves:** Circle, Bezier, B-Splines **Analytic Geometry:** Review of Geometry, 2D Analytic Geometry, Intersection Points, Point in Triangle, and Intersection of circle with straight line.	
Unit III	**Introduction to Rendering Engines:** Understanding the current market Rendering Engines. Understanding AR, VR and MR.Depth Mappers, Mobile Phones, Smart Glasses, HMD's **Unity Engine: Multi-platform publishing, VR + AR:** Introduction and working in Unity, 2D, Graphics, Physics, Scripting, Animation, Timeline, Multiplayer and Networking, UI, Navigation and Pathfinding, XR, Publishing. **Scripting:** Scripting Overview, Scripting Tools and Event Overview **XR:** VR, AR, MR, Conceptual Differences. SDK, Devices	15 L

Reference book:
- Mathematics for Computer Graphics, John Vince, Springer-Verlag London, 5th Edition,2017
- Mathematics for 3D Game Programming and Computer Graphic, Eric Lengyel, Delmar Cengage Learning, Delmar Cengage Learning,2011
- Introduction To 3D Game Programming With Directx® 11,Frank D Luna, Mercury Learning And Information,2012.
- https://docs.unity3d.com/Manual/index.html - Free

Text book:
- Techmax publication book

Additional References:
- Computer Graphics, C Version, Donald Hern and Pauline Baker, Pearson Education, 2nd Edition, 1997
- HLSL Development Cookbook, Doron Feinstein, PACKT Publishing,2013

Semester V – Practical

Course: USCSP50	Practical of USCST57 (Credits : 1, Lectures/Week: 3)
USCSP50	1. Setup DirectX 11, Window Framework and Initialize Direct3D Device 2. Buffers, Shaders and HLSL (Draw a triangle using Direct3D 11) 3. Texturing (Texture the Triangle using Direct 3D 11) 4. Lightning (Programmable Diffuse Lightning using Direct3D 11) 5. Specular Lightning (Programmable Spot Lightning using Direct3D 11) 6. Loading models into DirectX 11 and rendering. **Perform following Practical using online content from the Unity Tutorials Web--sites:** **https://unity3d.com/learn/tutorials/s/interactive-tutorials** 7. https://unity3d.com/learn/tutorials/s/2d-ufo-tutorial 8. https://unity3d.com/learn/tutorials/s/space-shooter-tutorial 9. https://unity3d.com/learn/tutorials/s/roll-ball-tutorial 10. https://unity3d.com/learn/tutorials/topics/vr/introduction?playlist=22946

Semester V – Practical

Course: **USCSP5X**	**Project Implementation** **(Credits : 1, Lectures/Week: 3)**
USCSP5X	**Project Implementation Guidelines** - A learner is expected to carry out two different projects: one in Semester V and another in Semester VI. - 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. - The Project has to be performed individually. - A learner is expected to devote around three months of efforts in the project. - The project can be application oriented/web-based/database/research based. - It has to be an implemented work; just theoretical study will not be acceptable. - 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. - 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. - 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. - A learner has to maintain a project report with the following subsections a) Title Page b) Certificate A certificate should contain the following information – 1. The fact that the student has successfully completed the project as per the syllabus 2. And that it forms a part of the requirements for completing the BSc degree in computer science of University of Mumbai. 3. The name of the student and the project guide 4. The academic year in which the project is done 5. Date of submission,

| | | 6. Signature of the project guide and the head of the department with date along with the department stamp, |
| | | 7. 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.

- The size of the project report shall be around twenty to twenty five pages, excluding the code.
- The Project report should be submitted in a spiral bound form
- The Project should be certified by the concerned Project guide and Head of the department.
- A learner has to make a presentation of working project and will be evaluated as per the Project evaluation scheme.

Semester VI – Theory

Course: USCST61	Wireless Sensor Networks and Mobile Communication (Credits : 3, Lectures/Week: 3)	
Objectives: In this era of wireless and adhoc network, connecting different wireless devices and understanding their compatibility is very important. Information is gathered in many different ways from these devices. Learner should be able to conceptualize and understand the framework. On completion, will be able to have a firm grip over this very important segment of wireless network. **Learning Outcomes:** After completion of this course, learner should be able to list various applications of wireless sensor networks, describe the concepts, protocols, design, implementation and use of wireless sensor networks. Also implement and evaluate new ideas for solving wireless sensor network design issues.		
Unit I	**Introduction:** Introduction to Sensor Networks, unique constraints and challenges. Advantage of Sensor Networks, Applications of Sensor Networks, Mobile Adhoc NETworks (MANETs) and Wireless Sensor Networks, Enabling technologies for Wireless Sensor Networks. **Sensor Node Hardware and Network Architecture:** Single-node architecture, Hardware components & design constraints, Operating systems and execution environments, introduction to TinyOS and nesC. Network architecture, Optimization goals and figures of merit, Design principles for WSNs, Service interfaces of WSNs, Gateway concepts.	15 L
Unit II	**Medium Access Control Protocols:** Fundamentals of MAC Protocols, MAC Protocols for WSNs, Sensor-MAC Case Study. **Routing Protocols** : Data Dissemination and Gathering, Routing Challenges and Design Issues in Wireless Sensor Networks, Routing Strategies in Wireless Sensor Networks. **Transport Control Protocols:** Traditional Transport Control Protocols, Transport Protocol Design Issues, Examples of Existing Transport Control Protocols, Performance of Transport Control Protocols.	15 L
Unit III	**Introduction, Wireless Transmission and Medium Access Control:** Applications, A short history of wireless communication. **Wireless Transmission:** Frequency for radio transmission,	15 L

| | Signals, Antennas, Signal propagation, Multiplexing, Modulation, Spread spectrum, Cellular systems.
Telecommunication, Satellite and Broadcast Systems: GSM: Mobile services, System architecture, Radio interface, Protocols, Localization And Calling, Handover, security, New data services; DECT: System architecture, Protocol architecture; ETRA, UMTS and IMT- 2000.
Satellite Systems: History, Applications, Basics: GEO, LEO, MEO;Routing, Localization, Handover. | |

Reference book:
- Protocols and Architectures for Wireless Sensor Network, Holger Kerl, Andreas Willig,John Wiley and Sons, 2005
- Wireless Sensor Networks Technology, Protocols, and Applications ,Kazem Sohraby, Daniel Minoli and TaiebZnati, John Wiley & Sons, 2007
- Mobile communications, Jochen Schiller,2nd Edition, Addison wisely , Pearson Education,2012

Text book:
- Techmax publication book

Additional References:
- Fundamentals of Wireless Sensor Networks, Theory and Practice, Waltenegus Dargie, Christian Poellabauer , Wiley Series on wireless Communication and Mobile Computing, 2011
- Networking Wireless Sensors, Bhaskar Krishnamachari , Cambridge University Press, 2005

Semester VI – Practical

Course: USCSP68	Practical of USCST61 (Credits : 1, Lectures/Week: 3)
USCSP68	*Practical experiments require software tools like INET Framework for OMNeT++, NetSim , TOSSIM, Cisco packet tracer 6.0 and higher version.* 1. Understanding the Sensor Node Hardware. (For Eg. Sensors, Nodes(Sensor mote), Base Station, Graphical User Interface.) 2. Exploring and understanding TinyOS computational concepts:-Events, Commands and Task. - nesC model - nesC Components

	3. Understanding TOSSIM for - Mote-mote radio communication - Mote-PC serial communication 4. Create and simulate a simple adhoc network 5. Understanding, Reading and Analyzing Routing Table of a network. 6. Create a basic MANET implementation simulation for Packet animation and Packet Trace. 7. Implement a Wireless sensor network simulation. 8. Create MAC protocol simulation implementation for wireless sensor Network. 9. Simulate Mobile Adhoc Network with Directional Antenna 10. Create a mobile network using Cell Tower, Central Office Server, Web browser and Web Server. Simulate connection between them.

Semester VI – Theory

Course: USCST62	Cloud Computing (Credits : 3, Lectures/Week: 3)	
Objectives: To provide learners with the comprehensive and in-depth knowledge of Cloud Computing concepts, technologies, architecture, implantations and applications. To expose the learners to frontier areas of Cloud Computing, while providing sufficient foundations to enable further study and research. **Learning Outcomes:** After successfully completion of this course, learner should be able to articulate the main concepts, key technologies, strengths, and limitations of cloud computing and the possible applications for state-of-the-art cloud computing using open source technology. Learner should be able to identify the architecture and infrastructure of cloud computing, including SaaS, PaaS, IaaS, public cloud, private cloud, hybrid cloud, etc. They should explain the core issues of cloud computing such as security, privacy, and interoperability.		
Unit I	Introduction to Cloud Computing, Characteristics and benefits of Cloud Computing, Basic concepts of Distributed Systems, Web 2.0, Service-Oriented Computing, Utility-Oriented Computing. Elements of Parallel Computing. Elements of Distributed Computing. Technologies for Distributed Computing. Cloud Computing Architecture. The cloud reference model. Infrastructure as a service. Platform as a service. Software as a service. Types of clouds.	**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**
Reference book: • Mastering Cloud Computing, Rajkumar Buyya, Christian Vecchiola, S Thamarai Selvi, TataMcGraw Hill Education Private Limited, 2013		

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

Text book:
- Techmax publication book

Additional References:
- 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

Semester VI – Practical

Course: USCSP68	Practical of USCST62 (Credits : 1, Lectures/Week: 3)
USCSP68	1. Study and implementation of Infrastructure as a Service. 2. Installation and Configuration of virtualization using KVM. 3. Study and implementation of Infrastructure as a Service 4. Study and implementation of Storage as a Service 5. Study and implementation of identity management 6. Study Cloud Security management 7. Write a program for web feed. 8. Study and implementation of Single-Sing-On. 9. User Management in Cloud. 10. Case study on Amazon EC2/Microsoft Azure/Google Cloud Platform

Semester VI – Theory

Course: USCST63	Cyber Forensics (Credits : 3, Lectures/Week: 3)	
Objectives: To understand the procedures for identification, preservation, and extraction of electronic evidence, auditing and investigation of network and host system intrusions, analysis and documentation of information gathered. **Learning Outcomes:** The student will be able to plan and prepare for all stages of an investigation - detection, initial response and management interaction, investigate various media to collect evidence, report them in a way that would be acceptable in the court of law.		
Unit I	**Computer Forensics :** Introduction to Computer Forensics 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 **Network Forensic :** Introduction to Network Forensics and tracking network traffic, Reviewing Network Logs, Network Forensics Tools, Performing Live Acquisitions, Order of Volatility, Standard Procedure **Cell Phone and Mobile Device Forensics:** Overview, Acquisition Procedures for Cell Phones and Mobile Devices	15 L
Unit II	**Internet Forensic :** **Introduction** to Internet Forensics, World Wide Web Threats, Hacking and Illegal access, Obscene and Incident transmission, Domain Name Ownership Investigation, Reconstructing past internet activities and events **E-mail Forensics :** e-mail analysis, e-mail headers and spoofing, Laws against e-mail Crime, **Messenger Forensics:** Yahoo Messenger **Social Media Forensics:** Social Media Investigations **Browser Forensics:** Cookie Storage and Analysis, Analyzing Cache and temporary internet files, Web browsing activity reconstruction	15 L
Unit III	**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	15 L

| | **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 | |

Reference book:
- Guide to computer forensics and investigations, Bill Nelson, Amelia Philips and Christopher Steuart, course technology,5th Edition,2015

Text book:
- Techmax publication book

Additional References:
- Incident Response and computer forensics, Kevin Mandia, Chris Prosise, Tata McGrawHill,2nd Edition,2003

Semester VI – Practical

Course: USCSP68	**Practical of USCST63** **(Credits : 1, Lectures/Week: 3)**
USCSP68	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

Semester VI – Theory

Course: USCST64	Information Retrieval (Credits : 3, Lectures/Week: 3)	
Objectives: To provide an overview of the important issues in classical and web information retrieval. The focus is to give an up-to- date treatment of all aspects of the design and implementation of systems for gathering, indexing, and searching documents and of methods for evaluating systems. **Learning Outcomes:** After completion of this course, learner should get an understanding of the field of information retrieval and its relationship to search engines. It will give the learner an understanding to apply information retrieval models.		
Unit I	**Introduction to Information Retrieval:** Introduction, History of IR, Components of IR, and Issues related to IR, Boolean retrieval, Dictionaries and tolerant retrieval.	**15 L**
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.	**15 L**
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.	**15 L**
Reference book: • Introduction to Information Retrieval, C. Manning, P. Raghavan, and H. Schütze, Cambridge University Press, 2008 • Modern Information Retrieval: The Concepts and Technology behind Search, Ricardo Baeza -Yates and Berthier Ribeiro – Neto, 2nd Edition, ACM Press Books 2011. • Search Engines: Information Retrieval in Practice, Bruce Croft, Donald Metzler and Trevor Strohman, 1st Edition, Pearson, 2009. **Text book:** • Techmax publication book		

Additional References: • 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)	

Semester VI – Practical

Course: USCSP69	Practical of USCST64 (Credits : 1, Lectures/Week: 3)
USCSP69	*Practical may be done using software/tools like Python / Java / Hadoop* 1. Write a program to demonstrate bitwise operation. 2. Implement Page Rank Algorithm. 3. Implement Dynamic programming algorithm for computing the edit distance between strings s1 and s2. (Hint. Levenshtein Distance) 4. Write a program to Compute Similarity between two text documents. 5. Write a map-reduce program to count the number of occurrences of each alphabetic character in the given dataset. The count for each letter should be case-insensitive (i.e., include both upper-case and lower-case versions of the letter; Ignore non-alphabetic characters). 6. Implement a basic IR system using Lucene. 7. Write a program for Pre-processing of a Text Document: stop word removal. 8. Write a program for mining Twitter to identify tweets for a specific period and identify trends and named entities. 9. Write a program to implement simple web crawler. 10. Write a program to parse XML text, generate Web graph and compute topic specific page rank.

Semester VI – Theory

Course: USCST65	Digital Image Processing (Credits : 3, Lectures/Week: 3)	
Objectives: To study two-dimensional Signals and Systems. To understand image fundamentals and transforms necessary for image processing. To study the image enhancement techniques in spatial and frequency domain. To study image segmentation and image compression techniques. **Learning Outcomes:** Learner should review the fundamental concepts of a digital image processing system. Analyze the images in the frequency domain using various transforms. Evaluate the techniques for image enhancement and image segmentation. Apply various compression techniques. They will be familiar with basic image processing techniques for solving real problems.		
Unit I	**Introduction to Image-processing System :** Introduction, Image Sampling, Quantization, Resolution, Human Visual Systems, Elements of an Image-processing System, Applications of Digital Image Processing **2D Signals and Systems :** 2D signals, separable sequence, periodic sequence, 2D systems, classification of 2D systems, 2D Digital filter **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 **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.	15 L
Unit II	**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 **Binary Image processing :**Mathematical morphology, Structuring elements, Morphological image processing, Logical operations, Morphological operations, Dilation and Erosion, Distance Transform	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

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

Text book:
- Techmax publication book

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

Semester VI – Practical

Course: USCSP69	**Practical of USCST65** **(Credits : 1, Lectures/Week: 3)**
USCSP69	*Practical need to be performed using Scilab under Linux or Windows* 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

Semester VI – Theory

Course: USCST66	Data Science (Credits : 3, Lectures/Week: 3)	
Objectives: Understanding basic data science concepts. Learning to detect and diagnose common data issues, such as missing values, special values, outliers, inconsistencies, and localization. Making aware of how to address advanced statistical situations, Modeling and Machine Learning. **Learning Outcomes:** After completion of this course, the students should be able to understand & comprehend the problem; and should be able to define suitable statistical method to be adopted.		
Unit I	**Introduction to Data Science:** What is Data? Different kinds of data, Introduction to high level programming language + Integrated Development Environment (IDE), Exploratory Data Analysis (EDA) + Data Visualization, Different types of data sources, **Data Management:** Data Collection, Data cleaning/extraction, Data analysis & Modeling.	15 L
Unit II	**Data Curation:** Query languages and Operations to specify and transform data, Structured/schema based systems as users and acquirers of data Semi-structured systems as users and acquirers of data, Unstructured systems in the acquisition and structuring of data, Security and ethical considerations in relation to authenticating and authorizing access to data on remote systems, Software development tools, Large scale data systems, Amazon Web Services (AWS)	15 L
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	15 L

Reference book:
- Doing Data Science, Rachel Schutt and Cathy O'Neil, O'Reilly,2013
- Mastering Machine Learning with R, Cory Lesmeister, PACKT Publication,2015

Text book:
- Techmax publication book

Additional References:
- 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

Semester VI – Practical

Course: USCSP69	Practical of USCST66 (Credits : 1, Lectures/Week: 3)
USCSP69	*Practical shall be performed using R* 1. Practical of Data collection, Data curation and management for Unstructured data (NoSQL) 2. Practical of Data collection, Data curation and management for Large-scale Data system (such as MongoDB) 3. Practical of Principal Component Analysis 4. Practical of Clustering 5. Practical of Time-series forecasting 6. Practical of Simple/Multiple Linear Regression 7. Practical of Logistics Regression 8. Practical of Hypothesis testing 9. Practical of Analysis of Variance 10. Practical of Decision Tree

Semester VI – Theory

Course: USCST67	Ethical Hacking (Credits : 3, Lectures/Week: 3)	
Objectives: To understand the ethics, legality, methodologies and techniques of hacking. **Learning Outcomes:** Learner will know to identify security vulnerabilities and weaknesses in the target applications. They will also know to test and exploit systems using various tools and understand the impact of hacking in real time machines.		
Unit I	**Information Security : 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	**15 L**
Unit II	**Ethical Hacking – I (Introduction and pre-attack)** **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,	**15 L**

	which systems/apps, understanding functionality, black/gray/white, authenticated vs. unauthenticated, internal vs. external PT, Information gathering, Perform Manual and automated (Tools: WebInspect/Qualys, Nessus, Proxies, Metasploit) VA and PT, How WebInspect/Qualys tools work: Crawling/Spidering, requests forging, pattern matching to known vulnerability database and Analyzing results, Preparing report, Fixing security gaps following the report **Enterprise strategy** : Repeated PT, approval by security testing team, Continuous Application Security Testing, **Phases:** Reconnaissance/foot-printing/Enumeration, **Phases**: Scanning, Sniffing	
Unit III	**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 **Phases :** Covering your tracks : Steganography, Event Logs alteration **Additional Security Mechanisms** : IDS/IPS, Honeypots and evasion techniques, Secure Code Reviews (Fortify tool, OWASP Secure Coding Guidelines)	**15 L**

Reference book:
- Certified Ethical Hacker Study Guide v9, Sean-Philip Oriyano, Sybex; Study Guide Edition,2016
- CEH official Certified Ethical Hacking Review Guide, Wiley India Edition, 2007
.
Text book:
- Techmax publication book

Additional References:
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

Semester VI – Practical

Course: USCSP60	Practical of USCST67 (Credits : 1, Lectures/Week: 3)
USCSP60	1. Use Google and Whois for Reconnaissance 2. a) Use CrypTool to encrypt and decrypt passwords using RC4 algorithm b) Use Cain and Abel for cracking Windows account password using Dictionary attack and to decode wireless network passwords 3. a) Run and analyze the output of following commands in Linux – ifconfig, ping, netstat, traceroute b) Perform ARP Poisoning in Windows 4. Use NMap scanner to perform port scanning of various forms – ACK, SYN, FIN, NULL, XMAS 5. a) Use Wireshark (Sniffer) to capture network traffic and analyze b) Use Nemesy to launch DoS attack 6. Simulate persistent cross-site scripting attack 7. Session impersonation using Firefox and Tamper Data add-on 8. Perform SQL injection attack 9. Create a simple keylogger using python 10. Using Metasploit to exploit (Kali Linux)

Semester VI – Practical

Course: **USCSP6X**	**Project Implementation** **(Credits : 1, Lectures/Week: 3)**
USCSP6X	**Project Implementation Guidelines** • A learner is expected to carry out two different projects: one in Semester V and another in Semester VI. • 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. • The Project has to be performed individually. • A learner is expected to devote around three months of efforts in the project. • The project can be application oriented/web-based/database/research based. • It has to be an implemented work; just theoretical study will not be acceptable. • 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. • 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. • 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. • A learner has to maintain a project report with the following subsections a) Title Page b) Certificate A certificate should contain the following information – 8. The fact that the student has successfully completed the project as per the syllabus 9. And that it forms a part of the requirements for completing the BSc degree in computer science of University of Mumbai. 10. The name of the student and the project guide 11. The academic year in which the project is done 12. Date of submission,

		13. Signature of the project guide and the head of the department with date along with the department stamp,
		14. 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.

- The size of the project report shall be around twenty to twenty five pages, excluding the code.
- The Project report should be submitted in a spiral bound form
- The Project should be certified by the concerned Project guide and Head of the department.
- A learner has to make a presentation of working project and will be evaluated as per the Project evaluation scheme.

Scheme of Examination

Evaluation Scheme

I. **Internal Exam-30 Marks**

   i. **Activate participation and Regularity of a student in classroom activities – 10 marks**

   ii. **Online Test- 10 Marks**

     [Note: It will be conducted either using any open source learning management system such as Moodle (Modular object-oriented dynamic learning environment) or a test based on an equivalent online course on the contents of the concerned course (subject) offered by or build using MOOC (Massive Open Online Course) platform.]

   iii. **Seminars or Assignment or Other evaluation techniques- 10 Marks**

II. **External Evaluation-70 Marks**

   i. **Duration:** 150 Minutes / 2.5 Hours

   ii. **Theory question paper pattern**

Pattern		
Question	**Based on**	**Marks**
Q.1	Unit I, II, III	10
Q.2	Unit I	20
Q.3	Unit II	20
Q.4	Unit III	20

III. **Practical Examination**

   i. **Each subject carries 50 Marks**

     External Evaluation

       30 Marks for performance in practical exam + **05 marks** (Journal) + **05 marks** (Viva)

     Internal Evaluation

       10 marks for Performance in Regular Practicals

   ii. Minimum 75 % practical from each core subjects are required to be completed and written in the journal

iii.   Certified Journal is compulsory for appearing at the time of Practical Exam

iv.   **Practical and Project Examination:**

There will be separate Practical examination for Elective-I, II, Skill enhancement and project of these Elective-I 100, Elective-II: 100 and Skill enhancement: 50 and Project Implementation: 50.
In the Practical Examination of Elective-I and II, the student has to perform practical on each of the subjects chosen. The Marking Scheme for each of the Elective is given below:

	Subject Code	Experiment-I	Experiment-II	Total Marks
Elective-I	USCSP58 or USCSP68	<u>External Evaluation</u> 30 Marks for performance in practical exam + 05 marks (Journal) + 05 marks (Viva) <u>Internal Evaluation</u> 10 marks for Performance in Regular Practical **Total:50M**	<u>External Evaluation</u> 30 Marks for performance in practical exam + 05 marks (Journal) + 05 marks (Viva) <u>Internal Evaluation</u> 10 marks for Performance in Regular Practical **Total:50M**	100
Elective-II	USCSP59 or USCSP69	<u>External Evaluation</u> 30 Marks for performance in practical exam + 05 marks (Journal) + 05 marks (Viva) <u>Internal Evaluation</u> 10 marks for Performance in Regular Practical **Total:50M**	<u>External Evaluation</u> 30 Marks for performance in practical exam + 05 marks (Journal) + 05 marks (Viva) <u>Internal Evaluation</u> 10 marks for Performance in Regular Practical **Total:50M**	100
Project Implementation	USCSP5X or USCSP6X	Project Evaluation Scheme**	Project Evaluation Scheme**	50
Skill Enhancement	USCSP50 or USCSP60	<u>External Evaluation</u> 30 Marks for performance in practical exam + 05 marks (Journal) + 05 marks (Viva) <u>Internal Evaluation</u> 10 marks for Performance in Regular		50

		Practical **Total:50M**	
	Total Marks		**300**

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

v. **Project Evaluation Scheme:**

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

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

Program Outcomes (PO)

Our students in the computer science program should, at the time of their graduation, have:

- PO1: an ability to demonstrate computer science principles in real time computer software and hardware problems.
- PO2: an ability to identify, formulates, and review literature's to analyse and solve complex computer science problems.
- PO3: an ability to design, implement, and evaluate a computer-based system, component, process or program to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability and sustainability.
- PO4: an ability to use the techniques, skills and modern hardware and software tools necessary for computer science practices.
- PO5: the broad education necessary to understand the impact of computing in global, economic, environmental and societal context.
- PO6: an ability to understand professional, legal and ethical responsibilities as it pertains to computer science.
- PO7: an ability to function effectively as an individual, as a member or leader in diverse and multidisciplinary domains.
- PO8: an ability to effectively communicate technical information in speech, presentation and in writing.
- PO9: an ability to apply all principles and management skills in individual work and team work for project development in multidisciplinary domains.

Program Specific Outcomes (PSO)

PSO-1: Able to implement computer skill in the areas related to application development, website design, Data base, Hardware and networking.
PSO-2: Able to demonstrate basic knowledge in the areas such as, Software Engineering, Networking, Data base management, Web Technology and Operating Systems for building IT applications.
PSO-3: Able to implement algorithmic techniques by virtue of advance programming skills and Free and Open Source Software tools.
PSO-4: Design, model, program and test software systems and applications in varying domains including Networks, Embedded systems and Web technologies.

Program Educational Objectives (PEO)

- Develop within our graduates the IT proficiency and apply fruitfully the knowledge of Computer Science.
- Develop within our graduates, the ability to communicate effectively, function ethically and legally to fulfill societal needs.
- Instill commitment into graduates towards life-long learning to remain updated in the IT profession.

****