Academic Council Meeting No. and Date : April 21, 2023

Agenda Number : 4 **Resolution Number : 23,24 / 4.8 & 4.15**

Vidya Prasarak Mandal's

B. N. Bandodkar College of Science (Autonomous), Thane

Syllabus for

Programme : Bachelor of Science

Specific Programme : Computer Science

[T.Y.B.Sc. (Computer Science)]

VPM's B.N.Bandodkar College of Science (Autonomous), Thane

T.Y.B.Sc. (C.S.)

Structure of Programme

SEMESTER V

Course Code	Course Title	No. of Lectures	Credits
Elective-I (Select Any Two)			
BNBUSCS5T1	Artificial Intelligence	**45**	
BNBUSCS5T2	Linux Server Administration	**45**	
BNBUSCS5T3	Software Testing and Quality Assurance	**45**	
Elective-II (Select Any Two)			
BNBUSCS5T4	Information and Network Security	**45**	
BNBUSCS5T5	Architecting of IoT	**45**	
BNBUSCS5T6	Web Services	**45**	
Skill Enhancement			
BNBUSCS5T7	Game Programming	**45**	
Practical			
BNBUSCS5P1	Practical of Elective-I		
BNBUSCS5P2	Practical of Elective-II		
BNBUSCS5P3	Project Implementation		
BNBUSCS5P4	Practical of Skill Enhancement : USCS507		
Total		**375**	**20**

SEMESTER VI

Course Code	Course Title	No. of Lectures	Credits
Elective-I (Select Any Two)			
BNBUSCS6T1	Wireless Sensor Networks and Mobile Communication	**45**	
BNBUSCS6T2	Cloud Computing	**45**	
BNBUSCS6T3	Cyber Forensics	**45**	
Elective-II (Select Any Two)			
BNBUSCS6T4	Information Retrieval	**45**	
BNBUSCS6T5	Digital Image Processing	**45**	
BNBUSCS6T6	Data Science	**45**	
Skill Enhancement			
BNBUSCS6T7	Ethical Hacking	**45**	
Practical			
BNBUSCS6P1	Practical of Elective-I		
BNBUSCS6P2	Practical of Elective-II		
BNBUSCS6P3	Project Implementation		
BNBUSCS6P4	Practical of Skill Enhancement : USCS607		
Total		**375**	**20**

Semester V

Course Code **BNBUSCS5T1**	Course Title **Artificial Intelligence**	Credits 2	No. of Lectures

Course 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 1 :	**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**
UNIT 2 :	**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**
UNIT 3 :	**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**

Course Code **BNBUSCS5T2**	Course Title **Linux Server Administration**	Credits 2	No. of Lectures

Course 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 1 :	**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**
UNIT 2 :	**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),	**15**

	Network Authentication, OpenLDAP Server, Samba and LDAP, Network authentication system (Kerberos), Domain Name Service (DNS), Security	
UNIT 3 :	**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**

Course Code **BNBUSCS5T3**	**Course Title** **Software Testing and Quality Assurance**	**Credits** **2**	**No. of Lectures**

Course 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 1 :	**Software Testing and Introduction to quality :** Introduction, Nature of errors, an example for Testing, Definition of Quality , QA, QC, QM and SQA , SoftwareDevelopment 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**
UNIT 2 :	**Software Testing Strategies :** Strategic Approach to Software Testing, UnitTesting, 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 ProcessImprovement.	**15**
UNIT 3 :	**Software Quality Assurance :** Quality Concepts, Quality Movement, Background Issues, SQA activities, Software Reviews, Formal Technical Reviews, Formal approaches to SQA, Statistical Quality Assurance, Software Reliability, The ISO 9000 Quality Standards, , SQA Plan , Six sigma, Informal Reviews **Quality Improvement :** Introduction, Pareto Diagrams, Cause-effect Diagrams,Scatter Diagrams, Run charts **Quality Costs :** Defining Quality Costs, Types of Quality Costs, Quality Cost Measurement, Utilizing Quality Costs for Decision-Making	**15**

Course Code	**Course Title**	**Credits**	**No. of**

BNBUSCS5T4	Information and Network Security	2	Lectures
Course Outcomes: Understand the principles and practices of cryptographic techniques. Understand a variety of generic security threats and vulnerabilities, and identify & analyze particular security problemsfor a given application. Understand various protocols for network security to protect against the threats in a network			
UNIT 1 :	**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**
UNIT 2 :	**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**
UNIT 3 :	**Electronic Mail Security:** Pretty Good Privacy, S/MIME **IP Security:** Overview, Architecture, Authentication Header, Encapsulating Security Payload, Combining Security Associations, Key Management **Web Security:** Web Security Considerations, Secure Socket Layer and Transport Layer Security, Secure Electronic Transaction **Intrusion:** Intruders, Intrusion Techniques, Intrusion Detection **Malicious Software:** Viruses and Related Threats, Virus Countermeasures,DDOS **Firewalls:** Firewall Design Principles, Types of Firewalls		**15**

Course Code BNBUSCS5T5	Course Title Architecting of IoT	Credits 2	No. of Lectures
Course Outcomes: Learners are able to design & develop IoT Devices. They should also be aware of the evolving world ofM2M Communications and IoT analytics.			
UNIT 1 :	**IoT-An Architectural Overview**: Building architecture, Main design		**15**

	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	
UNIT 2 :	**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**
UNIT 3 :	**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**

Course Code **BNBUSCS5T6**	**Course Title** **Web Services**	**Credits** **2**	**No. of Lectures**
Course 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 1 :	**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**
UNIT 2 :	**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**
UNIT 3 :	**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		**15**

	Programming, WCF Feature Details. Web Service QoS	

Course Code **BNBUSCS5T7**	Course Title **Game Programming**	Credits **2**	No. of Lectures
Course 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 1 :	**Mathematics for Computer Graphics, DirectX Kickstart:** **Cartesian Coordinate system:** The Cartesian XY-plane, Function Graphs, Geometric Shapes, Polygonal Shapes, Areas of Shapes, Theorem of Pythagorasin 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, TheVector 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 aboutan 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**
UNIT 2 :	**DirectX Pipeline and Programming:** **Introduction To DirectX 11:** COM, Textures and Resources Formats, Theswap 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, 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		**15**

	Analytic Geometry: Review of Geometry, 2D Analytic Geometry, Intersection Points, Point in Triangle, and Intersection of circle with straight line.	
UNIT 3 :	**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**

Course Code **BNBUSCS5P1**	**Course Title** **Practicals of Elective -I**

Course Code **BNBUSCS501**	**Course Title** **Artificial Intelligence Practical**	**Credits** **2**	**No. of Lectures**

Practical shall be implemented in LISP

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 3by 4 world problem

Course Code **BNBUSCS502**	**Course Title** **Linux Server Administration Practical**	**Credits** **2**	**No. of Lectures**

- 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 connectedto 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 andWindows)
5. Install DNS Server BIND, Configure DNS server which resolves domain name or IP address, Install BIND 9, Configure BIND, Limit ranges you allow to access if needed.
6. Configure DHCP Server, Configure DHCP (Dynamic Host Configuration Protocol) Server, Configure NFS Server to share directories on your Network, Configure NFS Client. (Ubuntu and Windows Client OS)
7. Configure LDAP Server, Configure LDAP Server in order to share users' accounts in your local networks, Add LDAP User Accounts in the OpenLDAP Server, Configure LDAP Client in order to share users' accounts in your local networks. Install phpLDAPadmin to operate LDAP server via Web browser.
8. Configure NIS Server in order to share users' accounts in your local networks, Configure NIS Client to bind NIS Server.

9. Install MySQL to configure database server, Install phpMyAdmin to operate MySQL on web browser from Clients.
10. Install Samba to share folders or files between Windows and Linux.

Course Code **BNBUSCS503**	**Course Title** **Software Testing and Quality Assurance Practical**	**Credits** **2**	**No. of Lectures**

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 Bugtracking tools.

Course Code **BNBUSCS5P2**	**Course Title** **Practicals of Elective -II**

Course Code **BNBUSCS504**	**Course Title** **Information and Network security Practical**	**Credits** **2**	**No. of Lectures**

1. Write programs to implement the following Substitution Cipher Techniques:
   - Caesar Cipher

- Monoalphabetic Cipher

2 Write programs to implement the following Substitution Cipher Techniques:
- Vernam Cipher
- Playfair Cipher

3 Write programs to implement the following Transposition Cipher Techniques:
- Rail Fence Cipher
- Simple Columnar Technique

4 Write program to encrypt and decrypt strings using
- DES Algorithm
- AES Algorithm

5 Write a program to implement RSA algorithm to perform encryption / decryption of a given string.

6 Write a program to implement the Diffie-Hellman Key Agreement algorithm to generate symmetric keys.

7 Write a program to implement the MD5 algorithm compute the message digest.

8 Write a program to calculate HMAC-SHA1 Signature

9 Write a program to implement SSL. 10

Configure Windows Firewall to block:
- A port
- An Program
- A website

Course Code **BNBUSCS505**	**Course Title** **Architecting of IoT Practical**	**Credits** **2**	**No. of Lectures**

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.

Course Code **BNBUSCS506**	**Course Title** **Web Services Practical**	**Credits** **2**	**No. of Lectures**

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.

   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.

Course Code BNBUSCS5P3	Course Title Project Implementation Practica	Credits 2	No. of Lectures
Please Refer to Project Implementation Guidelines			

Course Code BNBUSCS5P4	Course Title Game Programming Practical	Credits 2	No. of Lectures

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

References

Course Code BNBUSCS5T1	Course Title Artificial Intelligence

Textbook(s):

1) Artificial Intelligence: A Modern Approach, Stuart Russell and Peter Norvig,3rd Edition, Pearson, 2010.

Additional Reference(s):

1) Artificial Intelligence: Foundations of Computational Agents, David L Poole,Alan K. Mackworth, 2nd Edition, Cambridge University Press ,2017.

2) Artificial Intelligence, Kevin Knight and Elaine Rich, 3rd Edition, 2017

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

Course Code	**Course Title**
BNBUSCS5T2	**Linux Server Administration**

Textbook(s):

1) Linux Administration: A Beginner's Guide, Wale Soyinka, Seventh Edition, McGraw-Hill Education, 2016

2) Ubuntu Server Guide, Ubuntu Documentation Team, 2016

Additional Reference(s):

1) Mastering Ubuntu Server, Jay LaCroix, PACKT Publisher, 2016

Course Code	**Course Title**
BNBUSCS5T3	**Software Testing and Quality Assurance**

Textbook(s):

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.

Additional Reference(s):

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

Course Code	**Course Title**
BNBUSCS5T4	**Information and Network Security**

Textbook(s):

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

Additional Reference(s):

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

Course Code	Course Title
BNBUSCS5T5	**Architecting of IoT**

Textbook(s):

1. From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence, Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stefan Avesand, StamatisKarnouskos, David Boyle,1st Edition, Academic Press, 2014.
2. Learning Internet of Things, Peter Waher, PACKT publishing, BIRMINGHAM – MUMBAI,2015

Additional References(s):

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

Course Code	Course Title
BNBUSCS5T6	**Web Services**

Textbook(s):

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

Additional Reference(s):

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

Course Code	Course Title
BNBUSCS5T7	**Game Programming**

Text Book(s):

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

Additional Reference(s):

1) Computer Graphics, C Version, Donald Hern and Pauline Baker, Pearson Education, 2nd Edition, 1997
3) HLSL Development Cookbook, Doron Feinstein, PACKT Publishing,2013

Semester VI

Course Code	Course Title	Credits	No. of Lectures
BNBUSCS6T1	**Wireless Sensor Networks and Mobile Communication**	**2**	

Course 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 sensornetwor Also implement and evaluate new ideas for solving wireless sensor network design issues.

UNIT 1 :	**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, Operatingsystems 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**
UNIT 2 :	**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**
UNIT 3 :	**Introduction, Wireless Transmission and Medium Access Control:** Applications, A short history of wireless communication. **Wireless Transmission:** Frequency for radio transmission, Signals, Antennas, Signal propagation, Multiplexing, Modulation, Spread spectrum, Cellular systems. **Telecommunication, Satellite and Broadcast Systems: GSM:** Mobile services, System architecture, Radio interface, Protocols, Localization And Calling, Handover, security, New data services; DECT: System architecture, Protocol architecture; ETRA, UMTS and IMT- 2000. Satellite Systems: History, Applications, Basics: GEO, LEO, MEO; Routing, Localization, Handover.	**15**

Course Code	Course Title	Credits	No. of Lectures
BNBUSCS6T2	**Cloud Computing**	**2**	

Course 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-ar cloud computing using open source technology. Learner should be able to identify thearchitecture and infrastructure of cloud computing, including SaaS, PaaS, IaaS, public cloud, private cloud, hybrid cloud, et

They should explain the core issues of cloud computing such as security, privacy, and interoperability.		
UNIT 1 :	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 aservice. Platform as a service. Software as a service. Types of clouds.	**15**
UNIT 2 :	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**
UNIT 3 :	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 Storagedeployment, Compute deployment, deploying and utilizing OpenStack in production environments, Building a production environment, Application orchestration using OpenStack Heat	**15**

Course Code	**Course Title**	**Credits**	**No. of Lectures**
BNBUSCS6T3	**Cyber Forensics**	**2**	
Course 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 away t would be acceptable in the court of law.			
UNIT 1 :	**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**
UNIT 2 :	**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		**15**

	Social Media Forensics: Social Media Investigations **Browser Forensics:** Cookie Storage and Analysis, Analyzing Cache and temporary internet files, Web browsing activity reconstruction	
UNIT 3 :	**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 **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	**15**

Course Code **BNBUSCS5T4**	**Course Title** **Information Retrieval**	**Credits** **2**	**No. of Lectures**
Course 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 1 :	**Introduction to Information Retrieval:** Introduction, History of IR, Components of IR, and Issues related to IR, Boolean retrieval, Dictionaries and tolerant retrieval.		**15**
UNIT 2 :	**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**
UNIT 3 :	**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**

Course Code **BNBUSCS6T5**	**Course Title** **Digital Image Processing**	**Credits** **2**	**No. of Lectures**
Course 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 1 :	**Introduction to Image-processing System :** Introduction, Image		**15**

	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	
UNIT 2 :	**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 **Colour Image processing :**Colour images, Colour Model, Colour image quantization, Histogram of a colour image	**15**
UNIT 3 :	**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**

Course Code **BNBUSCS6T6**	**Course Title** **Data Science**	**Credits** **2**	**No. of Lectures**
Course 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 1 :	**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		**15**

	& Modeling	
UNIT 2 :	**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**
UNIT 3 :	**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**

Course Code	**Course Title**	**Credits**	**No. of Lectures**
BNBUSCS6T7	**Ethical Hacking**	**2**	

Course 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 1 :	**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	**15**

	Case-studies : Recent attacks – Yahoo, Adult Friend Finder, eBay, Equifax, WannaCry, Target Stores, Uber, JP Morgan Chase, Bad Rabbit	
UNIT 2 :	**Ethical Hacking – I (Introduction and pre-attack)** **Introduction**: Black Hat vs. Gray Hat vs. White Hat (Ethical) hacking, Why isEthical 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 andPenetration Testing. **Approach : Planning** - Threat Modeling, set up security verification standards, Set up security testing plan – When, which systems/apps, understanding functionality, black/gray/white, authenticated vs. unauthenticated, internal vs. external PT, Information gathering, Perform Manual and automated (Tools: WebInspect/Qualys, Nessus, Proxies, Metasploit) VA and PT, How WebInspect/Qualys tools work: Crawling/Spidering, requests forging, pattern matching to known vulnerability database and Analyzing results, Preparing report, Fixing security gaps following the report **Enterprise strategy** : Repeated PT, approval by security testing team, Continuous Application Security Testing, **Phases:** Reconnaissance/foot-printing/Enumeration, **Phases**: Scanning, Sniffing	**15**
UNIT 3 :	**Ethical Hacking :Enterprise Security** **Phases : Gaining and Maintaining Access** : **Systems hacking** – Windows andLinux – Metasploit and Kali Linux, Keylogging, Buffer Overflows, PrivilegeEscalation, Network hacking - ARP Poisoning, Password Cracking, WEPVulnerabilities, MAC Spoofing, MAC Flooding, IPSpoofing, SYN Flooding,Smurf attack, **Applications hacking** : SMTP/Email-based attacks, VOIPvulnerabilities, 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 evasiontechniques, Secure Code Reviews (Fortify tool, OWASP Secure Coding Guidelines)	**15**

Course Code	**Course Title**
BNBUSCS6P1	**Practicals of Elective -I**

Course Code	**Course Title**	**Credits**	**No. of Lectures**
BNBUSCS601	**Wireless Sensor Networks and Mob**	**2**	

	Communication Practical		

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.

Course Code **BNBUSCS602**	**Course Title** **Cloud Computing Practical**	**Credits** **2**	**No. of Lectures**

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

Course Code BNBUSCS603	Course Title Cyber Forensics Practical	Credits 2	No. of Lectures

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

Course Code **BNBUSCS6P2**	**Course Title** **Practicals of Elective -II**

Course Code **BNBUSCS604**	**Course Title** **Information Retrieval Practical**	**Credits** **2**	**No. of Lectures**

Practical may be done using software/tools like Python / Java / Hadoop

1. Write a program to demonstrate bitwise operation.
2. Implement Page Rank Algorithm.
   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 identifytrends and named entities.
9. Write a program to implement simple web crawler.
10. Write a program to parse XML text, generate Web graph and compute topic specific page rank.

Course Code	Course Title	Credits	No. of Lectures
BNBUSCS605	**Digital Image Processing Practica**	**2**	

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 autocorrelation 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

Course Code	Course Title	Credits	No. of Lectures
BNBUSCS606	**Data Science Practical**	**2**	

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 asMongoDB)

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

Course Code **BNBUSCS6P3**	**Course Title** **Project Implementation**	**Credits** **2**	**No. of Lectures**
Please Refer to Project Implementation Guidelines			

Course Code **BNBUSCS6P4**	**Course Title** **Ethical Hacking Practical**	**Credits** **2**	**No. of Lectures**

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 todecode 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)

References

Course Code **BNBUSCS6T1**	**Course Title** **Wireless Sensor Networks and Mobile Communication**

Textbook(s):

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

Additional Reference(s):

1) Fundamentals of Wireless Sensor Networks, Theory and Practice, Waltenegus Dargie, Christian Poellabauer , Wiley Series on wireless Communication and Mobile Computing, 2011

2) Networking Wireless Sensors, Bhaskar Krishnamachari , Cambridge University Press, 2005

Course Code **BNBUSCS6T2**	**Course Title** **Cloud Computing**

Textbook(s):

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

Additional Reference(s)*:*

1) OpenStack Essentials, Dan Radez, PACKT Publishing, 2015
2) OpenStack Operations Guide, Tom Fifield, Diane Fleming, Anne Gentle, Lorin Hochstein, Jonathan Proulx, Everett Toews, and Joe Topjian, O'Reilly Media, Inc., 2014

3) https://www.openstack.org

Course Code	Course Title
BNBUSCS6T3	**Cyber Forensics**

Textbook(s):

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

Additional Reference(s)*:*

Incident Response and computer forensics, Kevin Mandia, Chris Prosise, TataMcGrawHill,2nd Edition,2003

Course Code	Course Title
BNBUSCS6T4	**Information Retrieval**

Text book(s):

1) Introduction to Information Retrieval, C. Manning, P. Raghavan, and H. Schütze, Cambridge University Press, 2008
2) Modern Information Retrieval: The Concepts and Technology behind Search, Ricardo Baeza -Yates and Berthier Ribeiro – Neto, 2nd Edition, ACM Press Books 2011.
3) Search Engines: Information Retrieval in Practice, Bruce Croft, Donald Metzler and Trevor Strohman, 1st Edition, Pearson, 2009.

Additional Reference(s):

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

Course Code	Course Title
BNBUSCS6T5	**Digital Image Processing**

Textbook(s):

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

Additional Reference(s)*:*

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

Course Code	Course Title

BNBUSCS6T6	Data Science

Textbook(s):

1) Doing Data Science, Rachel Schutt and Cathy O'Neil, O'Reilly,2013
2) Mastering Machine Learning with R, Cory Lesmeister, PACKT Publication,2015

Additional Reference(s):

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

Course Code	Course Title
BNBUSCS6T7	Ethical Hacking

Textbook(s):

1) Certified Ethical Hacker Study Guide v9, Sean-Philip Oriyano, Sybex; Study Guide Edition,2016
2) CEH official Certified Ethical Hacking Review Guide, Wiley India Edition, 2007

Additional Reference(s):

1) Certified Ethical Hacker: Michael Gregg, Pearson Education,1st Edition, 2013
2) Certified Ethical Hacker: Matt Walker, TMH,2011
3) http://www.pentest-standard.org/index.php/PTES_Technical_Guidelines
4) https://www.owasp.org/index.php/Category:OWASP_Top_Ten_2017_Project
5) https://www.owasp.org/index.php/Mobile_Top_10_2016-Top_10
6) https://www.owasp.org/index.php/OWASP_Testing_Guide_v4_Table_of_Contents
7) https://www.owasp.org/index.php/OWASP_Secure_Coding_Practices_-_Quick_Reference_Guide
8) https://cve.mitre.org/
9) https://access.redhat.com/blogs/766093/posts/2914051
10) http://resources.infosecinstitute.com/applications-threat-modeling/#gref
    http://www.vulnerabilityassessment.co.uk/Penetration%20Test.html

Project Implementation

Guidelines

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

    a) Title Page

    b) Certificate

    A certificate should contain the following information –

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

and date on which the project isevaluated.

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 thecode.
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 theProject evaluation scheme