

**PONDICHERRY UNIVERSITY**  
**DEPARTMENT OF COMPUTER SCIENCE**

**REGULATIONS AND SYLLABUS**

**Master of Technology**  
**(Network & Information Security)**

**(For CBSC System in Pondicherry University)**  
(Effective from the academic year 2018-2019)

**Eligibility for Admission**

B.Tech. / B.E. degree in computer science and Engineering / Information Technology / Electronics and Communication Engineering / Electrical and Electronics Engineering / Electronics and Instrumentation Engineering.

**OR**

M.Sc in Computer Science/ Information Technology/ Software Engineering with a minimum of 55% marks.

**OR**

MCA with Bachelors degree in Computer science/ Computer Applications/ Mathematics/ Statistics/ Physics/ Electronics/ Applied Science with a minimum of 55% marks in each degree.

**Duration of the Course**

The course duration shall normally be of two years duration spread over four semesters. The maximum duration to complete the course shall be 4 years.

**Medium**

The medium of instruction shall be English.

**Passing Minimum**

Passing Eligibility & Classification for the award of the Degree are as per the Choice Based Credit System norms of Pondicherry University.

**PONDICHERY UNIVERSITY  
DEPARTMENT OF COMPUTER SCIENCE**

**Master of Technology  
(Network & Information Security)**

**COURSE STRUCTURE**

<b>Course Category</b>	<b>Notation</b>	<b>Number of Credits</b>
Core Courses	H	43
Supportive Hard Core	SH	6
Elective Courses	SS	15
Laboratory	L	08
Out Reach Programmes: (Conferences/Symposiums/Technical Meets/Workshops/Etc.,)		01*
<b>Total</b>		<b>72</b>

# M.Tech(NIS) CURRICULUM

## FIRST SEMESTER

S.No.	Course Code	Course Title	H/S	Credits
1	CSNS611	Mathematics for Network Engineering	SH	3
2	CSNS612	Principles of Modern Cryptography	H	3
3	CSNS613	Operating Systems: Administration And Security	H	3
4	CSNS614	Network Management	H	3
5	CSNS615	Foundations of modern networking	H	3
6		Elective Course– 1	SS	3
7	CSNS616	Software Lab – 1	L	2
8	CSNS617	Software Lab – 2	L	2

## SECOND SEMESTER

S.No.	Course Code	Course Title	H/S	Credits
1	CSNS621	Resource Management Techniques	SH	3
2	CSNS622	Network Security	H	3
3	CSNS623	Distributed Systems and Security	H	3
4	CSNS624	Network Protocols	H	3
5	CSNS625	Wireless Communication Networks	H	3
6		Elective Course– 2	SS	3
7	CSNS626	Software Lab – 3	L	2
8	CSNS627	Software Lab – 4	L	2

## THIRD SEMESTER

S.No.	Course Code	Course Title	H/S	Credits
1	CSNS711	Project Work Phase – 1 *	H	4
2	CSNS712	Information Security Management and Standards	H	3
3		Elective Course– 3	SS	3
4		Elective Course– 4	SS	3

## FOURTH SEMESTER

S.No.	Course Code	Course	H/S	Credits
1		Elective Course – 5	SS	3
2	CSNS721	Project Work Phase – 2	H	6
3	CSNS722	Project Report & Viva Voce	H	6

- In case of failure due to lack of attendance or minimum internal marks, the course has to be repeated in the subsequent semester and only after successful completion, CSNS 721 and CSNS 722 could be credited. If failure is due to external marks only, the course can be credited along with CSNS 721 and CSNS 722

**LIST OF DOMAIN SPECIFIC ELECTIVES (15 Credits)**

Note: All Course Codes are to be preceded with ‘CSNS ’

Course Code	Domain & Course Title	H/S	Credits
<b><u>Domain Specific Electives</u></b>			
<b>(1) Cloud Computing</b>			
CSNS811	Cloud Computing Architecture	S	3
CSNS812	Cloud Storage infrastructure	S	3
CSNS813	Principles of security in Cloud Computing	S	3
CSNS814	Converged networks	S	3
CSNS815	Enterprise storage systems	S	3
CSNS816	Data center virtualization	S	3
CSNS817	Data center networking	S	3
<b>(2) Cyber Security</b>			
CSNS821	Cyber Forensics	S	3
CSNS822	Block Chain Technology	S	3
CSNS823	Pattern Recognition techniques in Cyber crime	S	3
CSNS824	Cyber Laws and Security Policies	S	3
CSNS825	Information Security and Risk Management	S	3
CSNS826	Intrusion Detection Systems and Firewall	S	3
CSNS827	Multimedia Security & forensics	S	3
<b>(3) Software Defined Networking</b>			
CSNS831	Software Defined Networks	S	3
CSNS832	Cloud Orchestration and NFV	S	3
CSNS833	Software Defined Optical Networks	S	3
CSNS834	SDN for Real Networks	S	3
CSNS835	Software Defined Radios	S	3
<b>(4) Internet Of Things</b>			
CSNS841	Internet - of -Things	S	3
CSNS842	IoT Architecture and Protocols	S	3
CSNS843	Embedded Systems	S	3
CSNS844	Privacy and Security in IoT	S	3
CSNS845	Big Data Analytics for IoT	S	3
CSNS846	Fog computing	S	3
CSNS847	Wireless Sensor Protocols and Programming	S	3
<b>(5) Wireless Computing</b>			
CSNS851	Radio network planning & optimization	S	3
CSNS852	Advanced Wireless Networks	S	3
CSNS853	Mobile Communication Networks	S	3
CSNS854	Ad Hoc Mobile Networks	S	3
CSNS855	Advanced Mobile Computing	S	3
CSNS856	High Speed Networks	S	3

# **M.Tech (NIS)**

# **First Semester**

## CSNS611: MATHEMATICS FOR NETWORK ENGINEERING

L	T	P	C
3	0	0	3

### **Pre-requisite:**

- *Basic knowledge on discrete mathematics – basic set theory and proof techniques, mathematic induction, graphs, relations, functions, and logic.*

### **Objectives:**

- *To develop the ability to use the concepts of Special Functions for solving problems on Networks.*
- *To analyse the Graph Theory algorithms and understand its applications in Networks.*
- *To impart knowledge on Numerical Methods that will come in handy to solve numerically the problems that arise in engineering. This will also serve as a precursor for future research.*
- *To acquire skills in analysing Queuing Models.*

### **Module-I:**

**9 hrs**

**Graph Theory Introduction:** Introduction to Graphs - Paths - Cycles - And Trails - Vertex Degrees and Counting - Directed Graphs - Trees and Distance: Basic Properties - Spanning Trees and Enumeration - Optimization and Trees.

### **Module-II:**

**9 hrs**

**Matching Connectivity and Flow:** Matching and Covers Algorithms and Applications - Matching in General Graphs. - Connectivity and Paths: Cuts and Connectivity - k-connected graphs – Network Flow Problems.

### **Module-III:**

**9 hrs**

**Planar Graphs - Edges and Cycles:** Planar Graphs - Embedding and Euler's Formula - Characterization of Planar graphs - Parameters of Planarity - Line Graphs and Edge-Coloring - Hamiltonian Cycles - Planarity - Coloring and Cycles - Applications in Networks.

### **Module-IV:**

**9 hrs**

**Introduction To Probability Theory:** Probability concepts - Random variables - moments - Moment Generating function - Binomial - Poisson - Geometric - Negative binomial - Exponential - Gamma - Weibull distributions - Functions of random variable - Chebyshev inequality - Application in Networks.

### **Module-V:**

**9 hrs**

**Queueing Theory:** Markovian queueing models - Little's formula - Multi-server queues - M/G/1 Queues - Pollaczek - Khintchine formula - Applications in Networks.

### **Text Book(s):**

1. *R J Wilson Introduction to Graph Theory, 4<sup>th</sup> Edition, Pearson Education 2003.*
2. *Reinhard Diestel Graph Theory, 2<sup>nd</sup> Edition, Springer- Verlag 2000.*
3. *Probability and Queuing Theory, Gunavathi K, S Chand & Company, December 2010.*

**Reference Book(s):**

1. *Probability - Statistics and Random Processes*, T Veerarajan, McGraw Hill Education 3<sup>rd</sup> edition, July 2017)
2. *Probability, Statistics and Queuing Theory*, Sundarapandian V, Prentice Hall India Learning Private Limited; 1 Edition (2009)
3. Jay Yellen, Jonathan L.Gross *Graph Theory and Its Applications*, CRC Press LLC 1998.

## CSNS612: PRINCIPLES OF MODERN CRYPTOGRAPHY

L	T	P	C
3	0	0	3

### **Pre-requisite:**

- *Basic knowledge Of Mathematics, Algorithms, Computer Networks*

### **Objectives:**

- *To gain knowledge about the mathematics of the cryptographic algorithms*
- *To get an insight into the working of different existing cryptographic algorithms*
- *To get an insight into the working of Authentication Mechanisms and Key Management*

### **Module-I:**

**9 hrs**

**Introduction:** Security Goals, Cryptographic attacks, Services and Mechanism, Techniques for Security Goals Implementation – Mathematics of Cryptography – Modular Arithmetic, Congruence and Matrices

### **Module-II:**

**9 hrs**

**Traditional Symmetric Key Ciphers :** Mathematics of Symmetric Key Cryptography – Algebraic Structures - Introduction to Modern Symmetric Key Ciphers- DES, Blowfish, IDEA, AES, RC5, - Modes of operation of Modern Symmetric Key Ciphers

### **Module-III:**

**9 hrs**

**Mathematics of Asymmetric Key Cryptography:** Primes, Primality Testing, Factorization, Chinese Remainder Theorem, Quadratic Congruence - Asymmetric Key Cryptography – RSA, ElGamal Cryptosystem, Elliptic Curve Cryptosystem, Public Key Infrastructure and Digital Certificates

### **Module-IV:**

**9 hrs**

**Message Integrity and Message Authentication:** Random Oracle Model, Message Authentication – Cryptographic Hash Functions – MD5, SHA-512 - Digital Signature – Process, Services, Attacks on Digital Signature, Digital Signature Schemes – RSA, El Gamal, Elliptic Curve – Variations and Applications

### **Module-V:**

**9 hrs**

**Entity Authentication:** Password based Authentication, Challenge Response Protocols, Zero Knowledge Protocols, Biometrics – Key Management – Symmetric key Distribution, Kerberos, Symmetric Key Agreement, Public Key Distribution, Hijacking

### **Text Book(s):**

1. *Behrouz A. Forouzan and Debdeep Mukhopadhyay, Cryptography and Network Security, third edition, Tata McGraw Hill, 2016*
2. *W. Stallings, Cryptography and Network Security Principles and practice, Sixth Edition, Pearson Education Asia, 2014.*



3. *AtulKahate, Cryptography and Network Security, Third Edition, McGraw Hill, July 2017*

**Reference Book(s):**

1. *Michael Stinson. D. Cryptography: Theory and Practice, third edition, Chapman & Hall/CRC, 2010*
2. *Modern cryptography: theory & practice, Wembo Mao, Pearson Education; First Edition, 2004.*

## CSNS613: OPERATING SYSTEMS: ADMINISTRATION AND SECURITY

L	T	P	C
3	0	0	3

### **Pre-requisite:**

- *Familiar with basic hardware and software aspects of computer systems organization.*

### **Objectives:**

- *Become knowledgeable in the concepts of various functions of operating systems*
- *Gain hands-on experience in the basic administration of a Linux system.*
- *Understand the concepts of securing operating systems.*

### **Module-I:**

**9 hrs**

**Introduction to Computer Architecture:** Introduction - Computer system Organization and Architecture- Operating System structure and operations- Protection and Security- Process Management- Process Scheduling – Inter process communication- Multi threading models- Semaphores- Deadlocks- Mutex - Critical Section problems.

### **Module-II:**

**9 hrs**

**Memory Management and File Systems:**Main Memory: Background - Swapping - Contiguous Memory Allocation - Segmentation - Paging - Structure of the Page Table algorithms Virtual Memory: Background - Demand Paging - Copy-on-Write - Page Replacement - Allocation of Frames - Disk Structure - Disk Scheduling - Disk Management - Swap-Space Management - RAID Structure - Stable-Storage Implementation- File Concept - Access Methods - Directory and Disk Structure

### **Module-III:**

**9 hrs**

**Windows and Other Operating Systems:** Design Principles - System Components - Terminal Services and Fast User- Switching - File System -Networking - Programmer Interface -Influential Operating Systems: Feature Migration- Early Systems – Atlas - XDS-940 - THE - RC 4000 - CTSS – MULTICS - IBM OS/360 - TOPS-20 -CP/M and MS/DOS - Macintosh Operating System and Windows – Mach.

### **Module-IV:**

**9 hrs**

**Linux Administration and Other Services:** Open source operating system- Linux Kernel architecture- User administration in Linux- Services offered by Linux OS- Configuration of email service, web service, DNS in Linux- Syntactical Interpretation of various files related to different services in Linux

### **Module-V:**

**9 hrs**

**Secure Operating Systems:** Protection: Principles of Protection - Domain of Protection - Access Matrix - Implementation of the Access Matrix - Access Control - Revocation of Access Rights - Capability-Based Systems - Language-Based Protection Security: The Security Problem - Program Threats - System and Network Threats - Cryptography as a

Security Tool - User Authentication - Implementing Security Defenses - Firewalling to Protect Systems and Networks - Computer-Security Classifications.

**Text Book(s):**

1. *Abraham Silberschatz, Peter Baer Galvin and Greg Gagne, "Operating System Concepts", John Wiley & Sons ,Inc., 9<sup>th</sup> Edition, 2012.*
2. *William Stallings, "Operating System: Internals and Design Principles", Prentice Hall, 7<sup>th</sup> Edition, 2012.*

**Reference Book(s):**

1. *Tom Adelstein and Bill Lubanovic, "Linux System Administration", O'Reilly Media, Inc., 1st Edition, 2007.*
2. *Trent Jaeger, "Operating Systems Security", Morgan & Claypool Publishers, 2008.*

## CSNS614: NETWORK MANAGEMENT

L	T	P	C
3	0	0	3

### **Pre-requisite:**

- *Introduction to Computer Networks and Data Structure*

### **Objectives:**

- *The purpose of the course is to provide the technical understanding and managerial view of network operations so that the heterogeneous architectures can easily be handled*
- *Students will gain an understanding of SNMP protocol and its roles in providing information about network devices to a management station.*

### **Module-I:**

**9 hrs**

**Problem Definition& Overview of Network Management:** What is Network Management? - Case histories on Network System - and Service Management - Challenges of IT managers - Network management business drivers - examples of management tools.

**Hands on:-**Using NS2/NS3/WireShark practice Packet Capturing during web page requests and reply - Investigate the packets for protocols, the values of the header fields and the packet sizes.

### **Module-II:**

**9 hrs**

**Basic Foundation and Management Concepts:**Network Management Goals, Standards & Models –Organization, Functional, Information, Communication Model - Network Monitoring - ASN.1, MIB, SMI,SMIv2, Role of NMS.

**Hands On-1.** Explore the features of network monitoring software (Eg. WireShark) like Filters, Flow Graphs (TCP), Statistics, and Protocol Hierarchies.

**Hands On-2.** Create files on Web Server –Try accessing the files from a remote machine - Capture the packets and observe the log file.(Same can be done for Folders on the Web Server and observe the log)

### **Module-III:**

**9 hrs**

**SNMP Network Management:**SNMPv1 Network Management Standard – Organization, Communication, and Functional Models - Structure of SNMP Management Information Standards – Headers – Messages – Operations – SNMPv2 System Architecture – Protocol – Protocol Specification – SNMPv3 Architecture.

**Hands On** -Install any open source NMS in the system (Like OpenNMS) and explore OAMP.

### **Module-IV:**

**9 hrs**

**RMON and TMN:** Remote Network Monitoring: RMON -Groups and Functions, RMON2 - Monitoring of Upper Layer Protocols. - Telecommunications Management Network: TMN

Introduction-TMN Operations– Conceptual Model – Standards– Management Service Architecture – Implementation issues.

**Hands On:** Design a Network with 1 router, 2 Switches, Server (PDC) and 3 to 4 clients - Establish communication between the devices - Create the rules in the router to drop/restrict the packets between nodes -Monitor the network activity

**Module-V:**

**9 hrs**

**Advance Network Management:** Cloud Network Architecture Management – Software Defined Network (SDN) – CORBA Based Management – XML Based Management – Comparison of Management Protocols.

**Text Book(s):**

- 1 *Mani Subramanian, Network Management, 2nd Edition, Pearson Education India Release, ISBN: 9788131727591, February 2010*
- 2 *William Stallings, SNMP,SNMPv2,SNMPv3, and RMON1 and 2, 3<sup>rd</sup> Edition, Person Education Asia, 1999*
- 3 *Simple Network Management Protocol (SNMP) 5.2.11, Ericsson AB, 2018*
- 4 *A.Clemm, "Network Management Fundamentals", Cisco Press, ISBN-13 978-158720-137-0, 2007*

**Reference Book(s):**

1. <http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.125.3183&rep=rep1&type=pdf>
2. <https://www.usi.edu/business/aforough/Chapter%2020.pdf>
3. <https://www.opennms.org/en>
4. [https://www.cisco.com/c/en/us/products/collateral/services/high-availability/white\\_paper\\_c11-453503.html](https://www.cisco.com/c/en/us/products/collateral/services/high-availability/white_paper_c11-453503.html)
5. <https://ns2projects.org/ns2-simulator-free-download/>
6. <https://www.wireshark.org/download.html>
7. <http://www.eolss.net/sample-chapters/c05/e6-108-12.pdf>
8. [https://www.gambitcomm.com/site/gambit3.shtml?gclid=CjwKCAjw-8nbBRBnEiwAqWt1zYy\\_Tw\\_mWayqIf5DDfeoSIZurFwDyQHmWM44NNYVXKnOKNfEidynDRoCnWkQAvD\\_BwE](https://www.gambitcomm.com/site/gambit3.shtml?gclid=CjwKCAjw-8nbBRBnEiwAqWt1zYy_Tw_mWayqIf5DDfeoSIZurFwDyQHmWM44NNYVXKnOKNfEidynDRoCnWkQAvD_BwE)

**Available Journals for Network Management:**

1. <https://ieeexplore.ieee.org/xpl/RecentIssue.jsp?punumber=4275028>
2. <https://onlinelibrary.wiley.com/journal/10991190>
3. <https://link.springer.com/journal/10922>
4. <https://dl.acm.org/citation.cfm?id=J332>

## CSNS615: FOUNDATIONS OF MODERN NETWORKING

L	T	P	C
3	0	0	3

### **Pre-requisite:**

- *Networking Basics: OSI Model, TCP, UDP, TCP/IP*

### **Objectives:**

- *Understand the principles behind the Modern Network approaches such as SDN NFV and IoT*
- *Ability to analyse Data Center topologies and virtualized environment*
- *Understand the data traversal over virtualized environment for IoT*
- *Design algorithms for virtualization over multi-tenant environments*

### **Module-I:**

**9 hrs**

**Modern Networking:** Networking Ecosystem -Network Architecture – 4G/5G - Cloud Computing - Internet Of Things - Types of Network and Internet Traffic - Demand: Big Data, Cloud Computing, and Mobile Traffic - Requirements: QoS and QoE - Routing Congestion Control - SDN and NFV - Modern Networking Elements

### **Module-II:**

**9 hrs**

**Software Defined Networks:** Network Requirements - The SDN Approach - SDN- and NFV-Related Standards - SDN Data Plane - OpenFlow Logical Network Device - OpenFlow Protocol - SDN Control Plane Architecture - REST API - SDN Application Plane

### **Module-III:**

**9 hrs**

**Virtualization:** Background and Motivation for NFV - Virtual Machines - NFV Concepts - NFV Reference Architecture - NFV Infrastructure - Virtualized Network Functions - NFV Management and Orchestration - NFV Use Cases - SDN and NFV

### **Module-IV:**

**9 hrs**

**The Internet of Things: Components:** The IoT Era - Scope of the Internet of Things - Components of IoT-Enabled Things - IoT World Forum Reference Model - ITU-T IoT Reference Model - IoTivity - Cisco IoT System - ioBridge - SDN and NFV over IoT Deployment- DevOps

### **Module-V:**

**9 hrs**

**Security:** Security Requirements - SDN Security - NFV Security - ETSI Security Perspective - IoT Security - The Patching Vulnerability - IoT Security and Privacy Requirements Defined by ITU-T – An IoT Security Framework - The Impact of the New Networking on IT Careers

### **Text Book(s):**

1. *“Foundations of Modern Networking: SDN, NFV, QoE, IoT, and Cloud” William Stallings Publisher: Addison-Wesley 2015*
2. *SDN and NFV Simplified: A Visual Guide to Understanding Software Defined Networks and Network Function Virtualization 1<sup>st</sup> Edition by Jim Doherty*

**Reference Book(s):**

1. *Network Function virtualization with a touch of SDN* by Paresh Shah, Syed Farrukh Hassan, Rajendra Chayapathi
2. *Software Defined Networks A Comprehensive Approach 1<sup>st</sup> Edition* by Paul Goransson  
Chuck Black

**M.Tech (NIS)**

**Second  
Semester**



## CSNS621: RESOURCE MANAGEMENT TECHNIQUES

L	T	P	C
3	0	0	3

### **Pre-requisite:**

- *Basic understanding of linear programming.*

### **Objectives:**

- *Be familiar with resource management techniques.*
- *Learn to solve problems in linear programming and Integer programming.*
- *Be exposed to CPM and PERT.*

### **Module-I:**

**9 hrs**

**Linear Programming:** Principal components of decision problem – Modeling phases – LP Formulation and graphic solution – Resource allocation problems – Simplex method – Sensitivity analysis.

### **Module-II:**

**9 hrs**

**Duality and Networks:** Definition of dual problem – Primal – Dual relationships – Dual simplex methods – Post optimality analysis – Transportation and assignment model – Shortest route problem.

### **Module-III:**

**9 hrs**

**Integer Programming:** Cutting plan algorithm – Branch and bound methods, Multistage (Dynamic) programming.

### **Module-IV:**

**9 hrs**

**Classical Optimisation Theory:** Unconstrained external problems, Newton – Raphson method – Equality constraints – Jacobean methods – Lagrangian method – Kuhn – Tucker conditions – Simple problems.

### **Module-V:**

**9 hrs**

**Object Scheduling:** Network diagram representation – Critical path method – Time charts and resource leveling – PERT.

### **Text Book(s):**

1. *H.A. Taha, "Operation Research", Prentice Hall of India, 2002.*
2. *J. K. Sharma, "Operations Research: Problems & Solutions", Macmillan publishers, 2003*

### **Reference Book(s):**

1. *R.Panneerselvam, 'Operations Research', Prentice Hall of India, 2004*
2. *Anderson 'Quantitative Methods for Business', 8<sup>th</sup> Edition, Thomson Learning, 2002.*
3. *Winston 'Operation Research', Thomson Learning, 2003.*
4. *Vohra, 'Quantitative Techniques in Management', Tata McGraw Hill, 2002.*
5. *Anand Sharma, 'Operation Research', Himalaya Publishing House, 2003.*

## CSNS622: NETWORK SECURITY

L	T	P	C
3	0	0	3

### **Pre-requisite:**

- *Good understanding of the basics of TCP/IP.*

### **Objectives:**

- *What is Network Security and why it is important.*
- *To know application and network layer security*
- *To provide knowledge on wireless and mobile security*

### **Module-I:**

**9 hrs**

**Introduction:** Introduction to Security in Networks – Characteristics of Networks – Intrusion – Kinds of security breaches – Plan of attack - Points of vulnerability – Methods of defense – Control measures – Effectiveness of controls

### **Module-II:**

**9 hrs**

**Application Layer Security:** PGP and S/MIME – Email – PGP –S/MIME – SSL Architecture –Handshake ,Change Cipher Space, Alert And Record Protocols – SSL Message Formats – Transport Layer Security

### **Module-III:**

**9 hrs**

**Network Layer Security:** Modes – Two Security Protocols – Security Association – Security Policy – Internet Key Exchange – System Security: Description – Buffer Overflow And Malicious Software – Malicious Programs – Intrusion Detection System – Firewall

### **Module-IV:**

**9 hrs**

**Wireless Network Security:** Wireless Security – Mobile Device Security -Wireless LAN Overview - Wireless LAN Security - Wireless Application Protocol Overview - Wireless Transport Layer Security - WAP End-To-End Security

### **Module-V:**

**9 hrs**

**Security In Mobile And Iot :** Security - Threats To SDN – NFV Security Attack Surfaces – ETSI Perspective – Cloud Security – Security Issues – Risks – Data Protection – Security As A Service – Addressing Cloud Security -IOT Security – Vulnerability Patching – Requirements By ITU-T – Security Framework

### **Text Book(s):**

1. *Behrouz A Forouzan, Cryptography and Network Security , McGraw-Hill Education, 2011*
2. *William Stallings, Network Security Essentials: Applications and Standards, Prentice Hall India, 4<sup>th</sup> Edition*
3. *Foundations of Modern Networking: SDN, NFV, QoE, IoT, and Cloud” William Stallings Publisher: Addison-Wesley 2015*
4. *William Stallings, Cryptography and Network Security: Principles and Standards, Prentice Hall India, 3rd Edition, 2003*

**Reference Book(s):**

1. *Charles P. Pleeger, Security in Computing, Person Education Asia.*
2. *Charlie Kaufman, Radia Perlman and Mike Speciner, Network Security: Private Communication in a public world, Prentice Hall India, 2nd Edition, 2002*
3. *William Stallings, Network Security Essentials: Applications and standards, Person Education Asia, 2000*
4. *Jyrki T. J. Penttinen , Wireless Communications Security: Solutions for the Internet of Things, John Wiley & Sons,2016*

## CSNS623: DISTRIBUTED SYSTEMS AND SECURITY

L	T	P	C
3	0	0	3

### **Pre-requisite:**

- *Good knowledge of network security and introduction to threats.*

### **Objectives:**

- *Become knowledgeable in the concepts of distributed systems and security*
- *Get the exposure to Threats and Vulnerabilities.*
- *To acquire knowledge on Host level and service level solutions*

### **Module-I:**

**9 hrs**

**Introduction:** Security in Engineering - Secure Development Lifecycle Processes - A Typical Security Engineering Process – Security Engineering Guidelines and Resources. Common Security Issues and Technologies: Security Issues, Common Security Techniques

### **Module-II:**

**9 hrs**

**Host-Level Threats and Vulnerabilities:** Transient code Vulnerabilities - Resident Code Vulnerabilities - Malware: Trojan horse – Spyware - Worms/Viruses – Eavesdropping – Job Faults. Infrastructure-Level Threats and Vulnerabilities: Network-Level Threats and Vulnerabilities - Grid Computing Threats and Vulnerabilities – Storage Threats and Vulnerabilities – Overview of Infrastructure Threats and Vulnerabilities.

### **Module-III:**

**9 hrs**

**Application-Level Threats and Vulnerabilities:** Application-Layer Vulnerabilities – Injection Vulnerabilities - Cross-Site Scripting (XSS) - Improper Session Management - Improper Error Handling - Improper Use of Cryptography - Insecure Configuration Issues - Denial of Service - Canonical Representation Flaws - Overflow Issues. Service-Level Threats and Vulnerabilities: SOA and Role of Standards - Service-Level Security Requirements - Service-Level Threats and Vulnerabilities - Service-Level Attacks - Services Threat Profile

### **Module-IV:**

**9 hrs**

**Host-Level Solutions:** Sandboxing – Virtualization - Resource Management – Proof-Carrying Code -Memory Firewall – Antimalware - Infrastructure-Level Solutions: Network-Level Solutions - Grid-Level Solutions - Storage-Level Solutions. Application-Level Solutions: Application-Level Security Solutions.

### **Module-V:**

**9 hrs**

**Service-Level Solutions:** Services Security Policy - SOA Security Standards Stack – Standards in Dept - Deployment Architectures for SOA Security - Managing Service-Level Threats - Compliance in Financial Services - SOX Compliance - SOX Security Solutions – Multilevel Policy-Driven Solution Architecture - Case Study: Grid - The Financial Application – Security Requirements Analysis. Future Directions - Cloud Computing Security – Security Appliances - User centric Identity Management - Identity-Based Encryption (IBE) - Virtualization in Host Security.

**Text Book(s):**

- 1 *Abhijit Belapurakar, Anirban Chakrabarti. "Distributed Systems Security: Issues. Processes and solutions.*

**Reference Book(s):**

- 1 *Rachid Guerraoui "Stabilization, Safety, and Security of Distributed Systems", Springer, 2010.*

## CSNS624: NETWORK PROTOCOLS

L	T	P	C
3	0	0	3

### **Pre-requisite:**

- *Basic understanding of computer networking and cryptography.*

### **Objectives:**

- *To have exposure on various protocols.*
- *Gain knowledge on various ISO protocols.*
- *Be exposed to various wireless protocols*

### **Module-I:**

**9 hrs**

**Application Layer Protocols:** TCP/IP, HTTP, SHTTP, LDAP, MIME,- POP& POP3-RMON-SNTP-SNMP. Presentation Layer Protocols-Light Weight Presentation Protocol Session layer protocols –RPC protocols-transport layer protocols-ITOT,RDP,RUDP,TALI,TCP/UDP, compressed TCP. Network layer Protocols – routing protocols-border gateway protocol-exterior gateway protocol-internet protocol IPv4- IPv6- Internet Message Control Protocol- IRDP

### **Module-II:**

**9 hrs**

**Data Link layer Protocol:** ARP – InARP – IPCP – IPv6CP – RARP – SLIP .Wide Area Network Protocols- ATM protocols – Broadband access Protocols – Point to Point Protocols – Other WAN Protocols- security issues.

### **Module-III:**

**9 hrs**

**Local Area Network and LAN Protocols:** ETHERNET Protocols – VLAN protocols – Wireless LAN Protocols – Metropolitan Area Network Protocol – Storage Area Network and SAN Protocols -FDMA, WIFI and WIMAX Protocols- security issues - Mobile IP – Mobile Support Protocol for IPv4 and IPv6 – Resource Reservation Protocol - Multi-casting Protocol – BGMP – IGMP – MSDP.

### **Module-IV:**

**9 hrs**

**ISO Protocols:** Application Layer- ISO ACSE: Association Control Service Element -ISO CMIP: Common Management Information Protocol - CMOT: CMIP over TCP/IP - ISO FTAM - ISO ROSE - ISO RTSE - ISO VTP - ISO-PP - ISO-SP - ISO-TP: OSI - TP0, TP1, TP2, TP3, TP4 - Network Layer CLNP: Connectionless Network Protocol (ISO-IP) -ISO CONP - ES-IS: IDR - IS-IS - Cisco Protocols: CDP: Cisco Discovery Protocol - CGMP – DTP – EIGRP - HSRP IGRP - ISL & DISL – RGMP - TACACS – VTP – XOT - Novell NetWare and Protocols - IPX - NCP - NLSP – SPX - IBM SMB – APPC - SNA NAU - NetBIOS – NetBEUI – APPN – DLSw - QLLC – SDLC - AppleTalk - SS7/C7 Protocols – BISUP – DUP - ISUP - MTP2 and MTP3: - SCCP – TCAP – TUP – CIFS - Microsoft SOAP - Xerox IDP - Toshiba FANP.

### **Module-V:**

**9 hrs**

**Wireless Personal Area Network:**IEEE 802.15 and Bluetooth – WPAN Communication Protocols – IEEE 802.16- IEEE 802.16A.WCDMA – Services – WCDMA Products – Networks- device addressing – System Addressing – Radio Signaling Protocol – Multimedia Signaling Protocol.

**Text Book(s):**

1. *Jielin Dong, “Networks Protocols Handbook”, Jawin Technologies Inc., 2005.*
2. *Bruce Potter and Bob Fleck, “802.11 Security”, O’Reilly Publications, 2002.*
3. *Lawrence Harte, “Introduction to WCDMA”, Althos Publishing, 2004.*

**Reference Book(s):**

1. *Ralph Oppliger “SSL and TSL: Theory and Practice”, Arttech House, 2009.*
2. *Jessica Fridrich, “Steganography in Digital Media: Principles, Algorithms, and Applications”, Cambridge university press, 2010.*
3. *Lawrence Harte, “Introduction to CDMA- Network services Technologies and Operations”, Althos Publishing, 2004.*
4. *Lawrence Harte, “Introduction to WIMAX”, Althos Publishing, 2005.*

## CSNS625: WIRELESS COMMUNICATION NETWORKS

L	T	P	C
3	0	0	3

### **Pre-requisite:**

- *Good understanding of the basics in networking.*

### **Objectives:**

- *To study about wireless LAN standards and it's important.*
- *To provide knowledge on Bluetooth and WAP*
- *To know about satellite communication*

### **Module-I:**

**9 hrs**

**Introduction:** Introduction to Wireless Networks - Wireless Network Topologies - Characteristics of the Wireless Medium -GSM Cellular Network concept - Cellular transmission principles Typical cell layout - Signals Transmission interference- Cell splitting - TDMA technology – Spread spectrum and CDMA technology - GPRS – 3G- 4G and Long term evolution- 5G

### **Module-II:**

**9 hrs**

**Wireless LAN Standards:** Evolution of IEEE 802.11- Introduction to IEEE 802.11 -General Description- Medium Access Control (MAC) for the IEEE 802.11 -WLANs Physical Layer for IEEE 802.11 -WLANs; Radio systems -IR Systems Applications

### **Module-III:**

**9 hrs**

**Bluetooth:**Bluetooth and IEEE 802.15- Bluetooth Specifications - Bluetooth Architectures - Bluetooth Protocols - Bluetooth Service Discovery - Bluetooth MAC - Bluetooth Packet Structure - Bluetooth Audio - Bluetooth Addressing - Bluetooth Limitations – Zigbee

### **Module-IV:**

**9 hrs**

**WAP:** The WAP Forum - WAP Service Model - WAP Protocol Architecture - WAP Programming Model – Mobile applications and Mobile IP - Mobile adhoc networks(MANET) Wireless Routing Protocol - Cluster Switch Gateway Routing (CSGR) - Ad Hoc On-Demand Distance Vector Routing (AODV). Dynamic Source Routing (DSR) - Zone Routing Protocol (ZRP) - Source Tree Adaptive Routing (STAR).

### **Module-V:**

**9 hrs**

**Satellite Communication:** Overview of Satellite Systems - Orbits and Launching Methods - Geostationary Orbit - Radio Wave propagation - Interference - Satellite Access - Satellites in Networks - Direct Broadcast Satellite (DBS) Television - Satellite Services - INSAT, VSAT, Remote Sensing- Satellite Mobile and Specialized Services

### **Text Book(s):**

1. *Cory Beard, William Stallings, Wireless Communication Networks and Systems2015, Pearson.*
2. *William Stallings, Wireless communications and Networks, 2 nd Edition, Pearson Education Asia, 2005.*



**Reference Book(s):**

1. *Jochen Schiller, Mobile Communications, 2nd Edition, Addison-Wesley, 2000.*
2. *Chai-KeongToh, AdHoc Mobile Wireless Networks: Protocols and Systems, Addison Wesley, 2002.*
3. *Dennis Roddy, Satellite Communications, Fourth Edition, McGraw hill 2008*

# **M.Tech (NIS)**

# **Third Semester**

## CSNS712: INFORMATION SECURITY MANAGEMENT AND STANDARDS

L	T	P	C
3	0	0	3

### **Pre-requisite:**

- *Familiarity with basic principles of information security.*

### **Objectives:**

- *Understand the management aspects of information security.*
- *To Discuss about Security life cycle and planning*
- *Demonstrate various security standardizations, for example, ISO/IEC 27002.*

### **Module-I:**

**9 hrs**

**Information Security Management:** Why Information Security Matters - Information Sensitivity Classification - Information Security Governance - The Computing Environment - Security of Various Components in the Computing Environment - Security Interdependence - CIA Triad - Security Goals versus Business Goals - The Security Star - Parker's View – Defence-In-Depth Security - Security Control – NSA Triad Introduction to Management Concepts: History - Managerial Skills - Mintzberg's Managerial Role - Strategic Management Concepts - IS Security Management Activities - The Information Security Management Cycle - IS Security Management versus Functional Management

### **Module-II:**

**9 hrs**

**Life Cycle and Plan:** The Information Security Life Cycle - Security Planning in the SLC - Security Analysis - Security Design - Security Implementation - Security Review - Continual Security - Security Plan - SP Development Guidelines- analysis – methodology – Security Plan : Security Policy, Standards, and Guidelines - Methodologies - on Computing Environment Partition - on Computing Boundaries - Benson's Security Policy Methodology - Business Continuity Planning: Business Disruptions - Business Continuity - Disaster Recovery - Responding to Business Disruptions - Developing a BCP

### **Module-III:**

**9 hrs**

**Security Analysis and Design:** Security Risk Management - Various Layers of Risk - The Risk Management Life Cycle - The Preparation Effort for Risk Management- A Sustainable Security - Information Needed to Manage Risks - Factors Affecting Security Risk - The ALE Risk Methodology - Operational, Functional, and Strategic Risks - Operational Risk Management: Naval Safety - The ABLE Methodology - (IFEAR ) IFEAR Methodology - Fault Tree Analysis - Event Tree Analysis - FTA-ETA Integration - Risk Management - History - ISO/IEC 27002 - Enhance Security - Measurement and Implementations - Enhance the ISO/IEC 27002-Based Security Posture - Technical Security Enhancement Based on ISO/IEC 27001- Organizations Interact with the Standards - General ISMS Framework - Model - The Process Approach - Development - Design - Security Inventory Needs - Integration - Self-Assessment for Compliance - Scoping

### **Module-IV:**

**9 hrs**

**Security Review and Continual Security:** Different Things to Different People - Audit Activities - Definition - Main Features - Application Audit - Relating to Corporate Security Policy - Structure - Security Audit versus IT Auditing - Applicable Security - Related Standards - Security Audit Grades - The Problem of Privacy - The Meaning of Privacy - HIPAA - The Privacy Rule - The HIPAA Security Rule - Administrative Safeguards - NIST on HIPAA - Conducting Effective Risk Analysis - Methods of Doing Business - Background of the Sarbanes–Oxley Act - Sarbanes – Oxley Act of 2002 - Major Provisions of - Management Assessment - IT Compliance - International Responses - Advantages to SOX Compliance - Foreign Whistle blowers and SOX - Reconciling SOX and European Conflicting Standards - EU Corporate Governance Initiatives - E.U.’s Eighth Directive - Planning IT Management for SOX: Delayed SOX Impact.

**Module-V:**

**9 hrs**

**Cyberterrorism and Homeland Security:** Security Economic Intelligence - Homeland Security - Cyber terrorism in the Literature - Cyber terrorism in the Real World: The FBI Perspective - U.S. Legislative Enactments and Proposed Programs - U.S. Criminal Statutes Affecting the Internet - Statutes and Executive Orders Concerned with Cyber terrorism - International Initiatives - Individual European State Approaches to Security and Counterterrorism.

**Text Book(s):**

1. *Bel G. Raggad, Information Security Management: Concepts and Practice, CRC Press.*
2. *Nina Godbole, Information Systems Security: Security Management, Metrics, Frameworks and Best Practices, First Edition, Wiley India Pvt Ltd, 2009.*
3. *Michael Whitman and Herbert Mattord, Management of Information Security, Fourth Edition, Cengage Learning, 2014.*

**Reference Book(s):**

1. *Michael Whitman and Herbert Mattord, Principles of Information Security, Fifth Edition, Cengage Learning, 2015.*
2. *Harold F. Tipton, Information Security Management Handbook, Sixth edition, CRC Press, 2012.*
3. *Thomas R. Peltier, Information Security Policies and Procedures, 2nd Edition, Auerbach Publications, 2004.*

**M.Tech (NIS)**

**Fourth  
Semester**

**M.Tech (NIS)**

**ELECTIVES**  
**(15 Credits)**

# **CLOUD COMPUTING**

## CSNS811: CLOUD COMPUTING ARCHITECTURE

L	T	P	C
3	0	0	3

### **Pre-requisite:**

- *Basic concepts of Operating Systems (how they work and operate at a high level): Windows, Linux and a bit of basic concepts about them.*

### **Objectives:**

- *Analyse the components of cloud computing showing how business agility in an organization can be created*
- *Evaluate the deployment of web services from cloud architecture*
- *Critique the consistency of services deployed from a cloud architecture*
- *Critically analyse case studies to derive the best practice model to apply when developing and deploying cloud based applications*

### **Module-I:**

**9 hrs**

**Cloud Computing Fundamental:** Understanding Cloud Computing - Origins and Influences - Basic Concepts and Terminology - Goals and Benefits - Risks and Challenges - Roles and Boundaries - Cloud Characteristics - Cloud Delivery Models - Cloud Deployment Models.

### **Module-II:**

**9 hrs**

**Enabling Technologies and Security:** Broadband Networks and Internet Architecture - Data Center Technology - Virtualization Technology - Web Technology - Multitenant Technology - Service Technology –Security: Basics - Threat Agents - Cloud Security Threats.

### **Module-III:**

**9 hrs**

**Cloud Computing Mechanisms:** Logical Network Perimeter - Virtual Server - Cloud Storage Device - Cloud Usage Monitor- Resource Replication- Ready-Made Environment - Automated Scaling Listener- Load Balancer- SLA Monitor - Audit Monitor- Failover System – Hypervisor- Resource Cluster- Multi-Device Broker - State Management Database - Remote Administration System - Resource Management System - SLA Management System- Billing Management System

### **Module-IV:**

**9 hrs**

**Security Mechanisms and Architecture:** Encryption - Hashing- Digital Signature -Public Key Infrastructure (PKI) Identity and Access Management - Single Sign-On (SSO) - Cloud-Based Security Groups - Fundamental Cloud Architectures - Advanced Cloud Architectures - Specialized Cloud Architectures

### **Module-V:**

**9 hrs**

**Working With Clouds:** Cloud Delivery Models - The Cloud Provider - The Cloud Consumer - Business Cost Metrics - Cloud Usage Cost Metrics- Cost Management Considerations - Service Quality Metrics



**Text Book(s):**

1. *Erl, Cloud Computing: Concepts, Technology & Architecture*
2. *Gautam Shroff, Enterprise Cloud Computing Technology Architecture Applications*
3. *Toby Velte, Anthony Velte, Robert Elsenpeter, Cloud Computing, A Practical Approach*

**Reference Book(s):**

1. *Dimitris N. Chorafas, Cloud Computing Strategies*

## CSNS812: CLOUD STORAGE INFRASTRUCTURE

L	T	P	C
3	0	0	3

### **Pre-requisite:**

- *Basic knowledge on virtualization.*

### **Objectives:**

- *Critically appraise the opportunities and challenges of information management*
- *Evaluate information storage management design in a cloud environment*
- *Analyse the role technology plays in the design of a storage solution in a cloud architecture*
- *Investigate how a global storage solution can be optimized so that it can be delivered successfully from the cloud*
- *Analyse how best to provide reliable access to information both locally and remotely using storage technologies*

### **Module-I:**

**9 hrs**

**Industry Trends and Perspectives:** The Importance of Data and Storage - Business Issues and IT Challenges - Business and IT Opportunities - Opportunity for Cloud, Virtualization, and Data Storage Networking - Common Cloud, Virtualization, and Storage Networking - Cloud, Virtualization, and Storage Networking -Cloud, Virtualization, and Data Storage: Server and Storage I/O Fundamentals - I/O Connectivity and Networking Fundamentals - IT Clouds - Virtualization: Servers, Storage, and Networking - Virtualization and Storage Services - Data and Storage - Infrastructure Resource Management : Managing Data Infrastructures for Cloud and Virtual Environments - Introduction to Infrastructure Resource Management - Understanding IT Resources - Managing IT - Service Offerings, Categories, and Technology Alignment - Gaining Situational Awareness and Control - From SRM to E2E SRA - Search and e-Discovery - Performance and Capacity Planning - Data Movement and Migration.

### **Module-II:**

**9 hrs**

**Security and Data Protection:** Being Secure Without Being Scared - Eliminating Blind Spots, Gaps in Coverage, or “Dark Territories” - Security Threat Risks and Challenges - Taking Action to Secure Your Resources - Securing Networks - Securing Storage - Virtual Servers, Physical Servers, and Desktops - Securing Clouds - Disposing of Digital Assets and Technology - Security Checklist - Data Protection: Backup/Restore and Business Continuance/Disaster Recovery - Data Protection Challenges and Opportunities - Protect, Preserve, and Serve Information Services - SLO and SLAs: How Much Availability Do You Need vs. Want - Common-Sense Data Protection - Virtual, Physical, and Cloud Data Protection - Modernizing Data Protection and Backup - Data Protection Checklist - Common HA-, BC-, and DR-Related Questions -

### **Module-III:**

**9 hrs**

**Measurements and Data Footprint Reduction:** Getting Started - Making Sense of Metrics and Measurements - Different Metrics for Different Audiences - Key Performance Indicators

- Compound Metrics - Measuring IT Resources and Services Delivery - Where to Get Metrics  
- Accounting and Chargeback - Benchmarks and Simulation Comparisons - Data Footprint Reduction: Enabling Cost-Effective - Getting Started - The Expanding Scope and Focus of Data Footprint Reduction - DFR Techniques - Metrics and Measurements - What to Look for in a DFR Technology Solution – DFR Techniques - Archiving - Compression and Compaction - Consolidation and Storage Tiering - Data De-duplication - Cloud and Virtual Data Storage Networking - DFR and RAID Configurations - Space-Saving Snapshots - Thin Provisioning - Common DFR Questions

**Module-IV:**

**9 hrs**

**Storage Services and Connectivity:** Tiered Storage - Storage Reliability, Availability, and Serviceability (RAS) - Aligning Storage Technology and Media to Application Needs - Storage Services and Functionalities - Storage System Architectures - Storage Virtualization and Virtual Storage - Common Storage Questions - Virtual Servers - Inside Virtual Servers and Virtual Machines - Virtual Desktop Infrastructure - Cloud and Virtual Servers - Can and Should All Servers or Desktops Be Virtualized? - Virtualization Beyond Consolidation: Enabling IT Agility - Common Virtualization Questions - Connectivity: Networking with Your Servers and Storage - Networking Challenges - I/O and Networking Bits and Bytes, Decoding Encoding - I/O and Networking Fundamentals - Server (Physical, Virtual and Cloud) Topics - I/O and Networking Devices - Converged and Unified Networking - Local Networking (DAS, SANs, and LANs) - Enabling Distance (MANs and WANs) - Cloud, Virtualization, and Management Topics - Configuring for Reliability, Availability, and Serviceability (RAS) - Common Networking Questions.

**Module-V:**

**9 hrs**

**Solution Packages and Management Tools:** Clarifying Cloud Confusion - IaaS, PaaS, SaaS, and AaaS - Accessing Clouds - Public Cloud Services - Private Clouds - Stacks and Solutions - PODs and Modular Data Center Components - Vendor Lock-in: The Good, the Bad, and the Ugly - Evaluating Cloud Servers and Solutions - Management and Tools - Software and Management Tools - Management Tool Interfaces - End-to-End Management - Licensing Topics - The Evolving Role of Management Tools - Hard vs. Soft Products - The Other IT Resources: People, Processes, and Policies - Applying What You Have Learned - Don't Be Afraid, but Look before You Leap - Addressing Issues and Challenges While Enabling Opportunities - What's Your Vision, Strategy, and Plan? - What to Consider When Evaluating Technologies, Techniques, and Services - Common Cloud, Virtualization and Data Storage - Futures, Trends, Perspectives, and Predictions.

**.Text Book(s):**

1. *Greg Schulz 2011, Cloud and Virtual Data Storage Networking*
2. *Marty Poniatowski, Foundations of Green IT*
3. *EMC, Information Storage and Management: Storing, Managing, and Protecting*

**Reference Book(s):**

1. *Volker Herminghaus, Albrecht Scriba,, Storage Management in Data Centers*
2. *Klaus Schmidt, High Availability and Disaster Recovery*

## CSNS813: PRINCIPLES OF SECURITY IN CLOUD COMPUTING

L	T	P	C
3	0	0	3

### **Pre-requisite:**

- *Familiarity with Information security.*

### **Objectives:**

- *Compare modern security concepts as they are applied to cloud computing*
- *Assess the security of virtual systems*
- *Evaluate the security issues related to multi-tenancy*
- *Appraise compliance issues that arise from cloud computing*

### **Module-I:**

**9 hrs**

**Architectural Concepts:** Business Requirements - Cloud Evolution, Vernacular, and Definitions - Roles and Responsibilities - Definitions - Foundational Concepts - Business Requirements Analysis - Boundaries of Cloud Models - Protecting Sensitive Data.

### **Module-II:**

**9 hrs**

**Data Classification and Security:** Data Inventory and Discovery - Jurisdictional Requirements - Data Rights Management - Cloud Data Life Cycle - Cloud Storage - Cloud Data Security Foundational Strategies - Security in the Cloud - Virtualization - Cloud Attack Surface - Disaster Recovery (DR)

### **Module-III:**

**9 hrs**

**Responsibilities and Application Security:** Foundations of Managed Services - Business Requirements - Shared Responsibilities by Service Type - Shared Administration of OS - Share Responsibilities - Lack of Physical Access - Training and Awareness - Common Cloud Application Deployment Pitfalls – Cloud SDLC - 148 ISO/IEC 27034-1 - Cloud Application Architecture - Assurance and Validation .

### **Module-IV:**

**9 hrs**

**Operations:** Physical/Logical - Security Training and Awareness - Basic Operational Application Security - Monitoring, Capacity, and Maintenance - Change and Configuration - Business Continuity and Disaster.

### **Module-V:**

**9 hrs**

**Legal and Compliance Issues:**Legal Requirements and Unique Risks in the Cloud Environment Potential Personal and Data Privacy Issues in the Cloud Environment Audit Processes, Methodologies, and Cloud - The Impact of Diverse Geographical Locations and Legal Jurisdictions - Business Requirements - Cloud Contract Design and Management for Outsourcing.

### **Text Book(s):**

1. *Brian T. O'Hara , Certified Cloud Security Professional*
2. *Ronald L. Krutz, Russell Dean Vines, Cloud Security*

3. *John Rittinghouse, James Ransome, Cloud Computing*
4. *J.R. ("Vic") Winkler, Securing the Cloud*

**Reference Book(s):**

1. *Cloud Security Alliance 2009, Security Guidance for Critical Areas of Focus in Cloud Computing*
2. *VMware Security Hardening Guide*
3. *Cloud Security Alliance 2010, Top Threats to Cloud Computing*
4. *NIST Guidelines on Security and Privacy in Public Cloud Computing*
5. *NIST Guide to Security for Full Virtualization Technologies*
6. *NIST The NIST Definition of Cloud Computing*
7. *William Hau, Rudolph Araujo et al How Virtualization Affects PCI DSS*  
[www.mcafee.com/us/resources/.../wp-how-virt-affect-pci-dss-part-1.pdf](http://www.mcafee.com/us/resources/.../wp-how-virt-affect-pci-dss-part-1.pdf)
8. *Chenxi Wang Compliance with Clouds: Caveat Emptor*

## CSNS814: CONVERGED NETWORKS

L	T	P	C
3	0	0	3

### **Pre-requisite:**

- Knowledge of basic networking concepts, routing protocols and IP addressing mechanisms.

### **Objectives:**

- Implement applications enabled by a multi-service convergent network
- Explain how real-time traffic is prioritized and carried within a data network.
- Engineer networks suitable for voice, multicast traffic and high-speed switched Internet based networks

### **Module-I:**

**9 hrs**

**Introduction:** Overview- rationale – Benefits – voice communication network – voice transmission schemes – public switched telephone network – integrated services digital network – call control – advanced intelligent networks – ATM networks –SONET

### **Module-II:**

**9 hrs**

**Data Networking Concepts:** Data characteristics – Synchronization – Data communication networks – network architecture – internet architecture – frame relay

### **Module-III:**

**9 hrs**

**Voice Packet and Modulation:** Voice packet processing increasing voice – voice by packet – coding techniques and standards - Modulation schemes – impairments with wireless communication and broadband systems – equalization – single carrier – multi carrier

### **Module-IV:**

**9 hrs**

**VOIP Networking:** Issues –H.323 – QoS issues - VOIP standards – signalling protocols – PINT – IP QoS – transport architectures – Voice over ATM – VoATM – Circuit Emulation Scheme – comparison of Voice over AAL Schemes – Voice over –Frame Relay Networks – VoFR model – VoRF over switched virtual circuits – Review Of Voice Over Packet Models

### **Module-V:**

**9 hrs**

**Converged Network Access Technologies:** Cable Network Access – DSL Access – Broadband Wireless Access Networks – Corporate Access Networks – Soft switch Model of VoIP - Benefits of Soft switch – Architecture Service Creation Environment.

### **Text Book(s):**

1. *Oliver C. Ibe, Converged Network Architectures: Delivering Voice over IP, ATM, and Frame Relay 1st Edition, Wiley*
2. *Connecting Networks v6 Companion Guide, Cisco Networking Academy*
3. *Scott Firestone, Thiya Ramalingam, Steve Fry 2007, Voice and Video Conferencing Fundamentals, 1st Ed. Ed., Cisco Press*
4. *CVOICE 8.0: Implementing Cisco Unified Communications Voice over IP and QoS*
5. *Eric Osborne, Ajay Simha 2003, Traffic engineering with MPLS, Cisco Press*

**Reference Book(s):**

1. *Amir Ranjbar 2007, CCNP ONT Official Exam Certification Guide, Cisco*
2. *Christina Hattingh, Darryl Sladden, ATM ZakariaSwapan 2010, SIP Trunking, Cisco Press*
3. *Website: Cisco Systems Inc. 2006, Voice/Data Integration Technologies*  
*[http://www.cisco.com/univercd/cc/td/doc/cisintwk/ito\\_doc/voicdata.htm](http://www.cisco.com/univercd/cc/td/doc/cisintwk/ito_doc/voicdata.htm)*

## CSNS815: ENTERPRISE STORAGE SYSTEMS

L	T	P	C
3	0	0	3

### **Pre-requisite:**

- *Understanding of key concepts related to cloud computing.*

### **Objectives:**

- *Evaluate various storage classifications and technologies.*
- *Analyse storage architectures, processes, components and how they relate to virtualization.*

### **Module-I:**

**9 hrs**

**Storage Systems:** Data Classification, Storage Evolution and Data Center infrastructure-Host components, Connectivity, Storage, and Protocols. Components of a disk drive, physical disk and factors affecting disk drive performance - RAID level performance and availability considerations - Components and benefits of an intelligent storage system.

### **Module-II:**

**9 hrs**

**Storage Networking Technologies:** Direct-Attached Storage (DAS) architecture, Storage Area Network (SAN) attributes components, topologies, connectivity options and zoning. FC protocol stack, addressing, flow control, and classes of service. Networked Attached Storage (NAS) components, protocols, IP Storage Area Network (IP SAN) iSCSI, FCIP and FCoE architecture. Content Addressed Storage (CAS) elements, storage, and retrieval processes.

### **Module-III:**

**9 hrs**

**Virtualization:** Block-level and file-level storage virtualization technology, virtual provisioning and cloud computing.

### **Module-IV:**

**9 hrs**

**Business Continuity:** Business Continuity measurement, terminologies, and planning. Backup designs, architecture, topologies, and technologies in SAN and NAS environments - Local and Remote replication using host and array-based replication technologies such as Synchronous and Asynchronous methods.

### **Module-V:**

**9 hrs**

**Storage Security and Management:** Storage security framework and various security domains - Security implementation in SAN, NAS and IP-SAN networking. Monitoring and Storage management activities and challenges

### **Text Book(s):**

1. *Information Storage and Management, EMC*
2. *Richard Barker, Paul Massiglia 2002, Storage area network essentials, Wiley NewYork*
3. *Ulf Troppens, Rainer Erkens, Wolfgang Mueller-Friedt, Rainer Wolafka, Nils Haustein, Storage Networks Explained*



**Reference Book(s):**

1. *W. Curtis Preston 2002, Using SANs and NAS, O'Reilly & Associates Sebastopol, Calif.*
2. *Himanshu Dwivedi 2006, Securing storage, Addison-Wesley Upper Saddle River, NJ*

## CSNS816: DATA CENTER VIRTUALIZATION

L	T	P	C
3	0	0	3

### **Pre-requisite:**

- *Familiarity with managing Virtual Environments.*

### **Objectives:**

- *Identify various constraints and challenges in setting up a data center*
- *Demonstrate Enterprise level virtualization and access control in virtual machines*
- *Discuss the components needed for end-to-end virtualization.*

### **Module-I:**

**9 hrs**

**Introduction:** Introduction Virtualization History and Definitions - Data Center Essential Definitions -The Origins of Data Center Virtualization Classifying Virtualization Technologies Data Center Network Evolution - Data Center Network Topologies - Network Virtualization Benefits.

### **Module-II:**

**9 hrs**

**VIRTUALIZATION IN NETWORK:**Network Partitioning - Defining VLANs - Misconceptions About VLANs - Spanning Tree - Private VLANs - Concepts - Overlapping Addresses - Defining and Configuring - Routing - Management Plane - Application Networking Services -Load Balancer Proliferation - ACE Virtual - Instant Switches: Virtual Device Contexts - Fooling Spanning Tree - Virtualized Chassis with Fabric Extenders.

### **Module-III:**

**9 hrs**

**Virtualization In Storage Technologies:** : Data Center Storage Devices - Accessing Data in Rest - Storage Virtualization - Some Fibre Channel Definitions - Fabric Processes - Defining and Exploring VSANs - Fibre Channel over IP - Inter-VSAN Routing - Data Center Bridging - Introducing Fibre Channel over Ethernet - Deploying Unified Server Access - Configuring Multihop FCoE - Unified Fabric Designs - FCoE and SAN Extension.

### **Module-IV:**

**9 hrs**

**Virtualization In Server Technologies:** Server Evolution - Server Provisioning Challenges - Unified Computing and Service Profiles - Verifying Stateless Computing - Using Policies - Firmware Policies - Industrializing Server Provisioning -Transcending the Rack - Moving Targets.

### **Module-V:**

**9 hrs**

**END-TO-END Virtualization:** The Virtual Data Center and Cloud Computing - The Virtual Data Center - Automation and Standardization - What Is Cloud Computing - Cloud Implementation - Journey to the Cloud - Networking in the Clouds - Software-Defined Networks - OpenStack - Network Overlays - Cisco Open Network Environment.

**Text Book(s):**

1. *Gustavo Alessandro , Data Center Virtualization Fundamentals*
2. *Mike Laverick, VMware vSphere 4 Implementation*
3. *Jason W. McCarty, Scott Lowe, Matthew K. Johnson, VMware vSphere Administration Instant Reference*

**Reference Book(s):**

1. *Brian Perry, Chris Huss, Jeantet Fields, VCP VMware Certified Professional on vSphere 4 Study Guide*
2. *Jason Kappel, Anthony Velte, Toby Velte, Microsoft Virtualization with Hyper-V: Manage Your Datacenter with Hyper-V, Virtual PC, Virtual Server, and Application Virtualization*

## CSNS817: DATA CENTER NETWORKING

L	T	P	C
3	0	0	3

### **Pre-requisite:**

- *Familiarity of Network function Virtualization*

### **Objectives:**

- *Critically discuss data center networking technologies and protocols*
- *Evaluate key concepts in modern Layer 2 & Layer 3 data center networks*
- *Research a topic related to networking technologies in modern data centers*
- *Design, build and configure complex routed and switched networks*

### **Module-I:**

**9 hrs**

**Evolution of Data Center Design:** Data Center Evolution – Computer Networks – Enterprise Vs Cloud Data Center- Movement Into The Cloud – Switch Fabric – Architecture - Topologies – Tradition Enterprise Networks – Datacenter Network Switch Types – Flat Data Center Networks – Rack Scale Architecture- Network Function Virtualization

### **Module-II:**

**9 hrs**

**Data Center Architectures:** Network connectivity optimization evolution: Top of rack (TOR), end of rack (EOR), scale up vs scale up, solutions that reduce power and cabling - Data Center standards; TIA/EIA-942 - Structured cabling standards, fiber and copper cabling characteristics, cable management, bandwidth requirements, I/O connectivity.

### **Module-III:**

**9 hrs**

**Server Architectures:** Stand-alone, blades, stateless, clustering, scaling, optimization, virtualization - Limitation of traditional server deployments - modern solutions - Applications; database, finance etc - Redundant Layer 2 and Layer 3 designs - Case studies.

### **Module-IV:**

**9 hrs**

**Layer 2 Networks:** Ethernet; IEEE 802.3ba; 40 Gbps and 100 Gbps Ethernet. IEEE 802.1D Spanning Tree Protocol (STP), RSTP, PVST, MSTP. TRILL (Transparent Interconnection of Lots of Links), RBridges, IEEE 802.1Qbg Edge Virtual Bridging, 802.1Qbh Bridge Port Extension – Fiber Channel over Ethernet (FCoE) vs Internet Small Computer System Interface (iSCSI). Data Center Bridging (DCB); priority-based flow control, congestion notification, enhanced transmission selection, Data Center Bridging Exchange (DCBX) - Layer 2 Multicasting; Case studies.

### **Module-V:**

**9 hrs**

**Layer3&Beyond:** Layer 3 Data Center technologies, network virtualization. Protocols; IPv4, IPv6, MPLS, OSPF, IS-IS, BGP. OTV, VPLS layer 2 extension protocols. Locator Identifier Separation Protocol (LISP) - Layer 3 Multicasting - Data Center application services - Data

center networking use case studies and the enabling technologies and protocols in the modern data center.

**Text Book(s):**

1. *Gary Lee, Cloud Networking: Understanding Cloud-based Data Center Networks*
2. *SilvanoGai, TommiSalli, Roger Andersson, Cisco Unified Computing System*
3. *Ron Fuller, David Jansen, Matthew McPherson, NX-OS and Cisco Nexus Switching: Next-Generation Data Center Architectures*
4. *SilvanoGai, Claudio DeSanti, I/O Consolidation in the Data Center*
5. *Kevin Corbin, Ron Fuller, David Jansen,, NX-OS and Cisco Nexus Switching: Next Generation Data Center Architectures*
6. *Data Center Virtualization Fundamentals Understanding Techniques And Designs*

**Reference Book(s):**

1. *Nash Darukhanawalla, Patrice Bellagamba, Interconnecting Data Centers Using VPLS*
2. *Robert W. Kembel, Roger Cummings (Introduction), The Fiber Channel Consultant*
3. *Fiber Channel Switched Fabric*
4. *John L. Hufferd 2003, ISCSI, Addison-Wesley Boston*

# **CYBER SECURITY**

## CSNS821: CYBER FORENSICS

L	T	P	C
3	0	0	3

### **Pre-requisite:**

- Knowledge on basic Cryptographic Algorithms and Protocols, Computer Networks, Web and Mobile Technology AND Security

### **Objectives:**

- Learn the security issues network layer and transport layer
- Be exposed to security issues of the application layer
- Learn computer forensics
- Be familiar with forensics tools
- Learn to analyse and validate forensics data

### **Module-I:**

**9 hrs**

**Legal and Ethical Principles :** Introduction to Forensics – The Investigative Process – Code of Ethics, Ethics of Investigations, Evidence Management – Collection, Transport, Storage, access control, disposition

### **Module-II:**

**9 hrs**

**Forensic Science:** Principles and Methods – Scientific approach to Forensics, Identification and Classification of Evidence, Location of Evidence, Recovering Data, Media File Forensic Steps, Forensic Analysis – Planning, Case Notes and Reports, Quality Control

### **Module-III:**

**9 hrs**

**Digital Forensics:** Hardware Forensics – Hidden File and Anti- forensics - Network Forensics – Virtual Systems - Mobile Forensics

### **Module-IV:**

**9 hrs**

**Application Forensics, Tools and Report Writing** – Application Forensics, Email and Social Media Investigations, Cloud Forensics, Current Digital Forensic Tools, Report Writing for Investigations

### **Module-V:**

**9 hrs**

**Counter Measures:** Defensive Strategies for Governments and Industry Groups, Tactics of the Military, Tactics of Private Companies, Information Warfare Arsenal of the future, and Surveillance Tools for Information Warfare of the Future.

### **Text Book(s):**

1. Bill Nelson, Christopher Steuart, Amelia Philips, “Computer Forensics and Investigations”, Delmar Cengage Learning; 5th edition January 2015
2. Chuck Eastom, “Certified Cyber Forensics Professional Certification:”, McGraw Hill, July 2017
3. John R.Vacca, “Computer Forensics: Computer Crime Scene Investigation”, Laxmi Publications, 2015

### **Reference Book(s):**

1. MarjieT.Britz, “Computer Forensics and Cyber Crime”: An Introduction”, 3<sup>rd</sup> Edition, Prentice Hall, 2013.

## CSNS822: BLOCK CHAIN TECHNOLOGY

L	T	P	C
3	0	0	3

### **Pre-requisite:**

- *Basic knowledge on Private Key Cryptography and P2P Network.*

### **Objectives:**

- *Understand crypto currency concepts*
- *Understand the working and transactions of bit coin*
- *Analyse the function Blockchain*

### **Module-I:**

**9 hrs**

**Introduction:** Bitcoin - History of Bitcoin - Uses, Users, Choosing a Bitcoin Wallet - Quick Start - Getting Your First Bitcoin - Finding the Current Price of Bitcoin - Sending and Receiving Bitcoin - How it Works, Transactions - Blocks, Mining, and the Blockchain Bitcoin Overview. Transaction Inputs and Outputs - Transaction Chains - Making Change - Common Transaction Forms - Constructing a Transaction - Getting the Right Inputs - Creating the Outputs - Adding the Transaction to the Ledger - Bitcoin Mining - Mining Transactions in Blocks - Spending the Transaction

### **Module-II:**

**9 hrs**

**Bitcoin Core:** The Reference Implementation - Bitcoin Development Environment - Compiling Bitcoin Core from the Source Code - Selecting a Bitcoin Core Release - Configuring the Bitcoin Core Build - Building the Bitcoin Core Executables - Running a Bitcoin Core Node - Running Bitcoin Core for the First Time - Configuring the Bitcoin Core Node - Bitcoin Core Application Programming Interface (API) - Getting Information on the Bitcoin Core Client Status - Exploring and Decoding Transactions - Exploring Blocks - Using Bitcoin Core

### **Module-III:**

**9 hrs**

**Wallets and Transactions:** Wallet Technology - Overview Nondeterministic (Random) Wallets - Deterministic (Seeded) Wallets - HD Wallets (BIP-32/BIP-44) - Seeds and Mnemonic Codes (BIP-39) - Wallet Best Practices - Using a Bitcoin Wallet - Wallet Technology Details - Mnemonic Code Words (BIP-39) - Creating an HD Wallet from the Seed - Using an Extended Public Key on a Web Store Transactions - Transactions in Detail - Transactions Behind the Scenes - Transaction Outputs and Inputs - Transaction Outputs - Transaction Inputs - Transaction Fees - Adding Fees to Transactions Transaction Scripts and Script Language - Turing Incompleteness - Stateless Verification - Script Construction (Lock + Unlock) - Pay-to-Public-Key-Hash (P2PKH) - Digital Signatures (ECDSA) - How Digital Signatures Work - Verifying the Signature - Signature Hash Types (SIGHASH) - ECDSA Math - The Importance of Randomness in Signatures - Bitcoin Addresses, Balances, and Other Abstractions



**Module-IV:****9 hrs**

**Advanced Transactions and Scripting:** Multisignature -Pay-to-Script-Hash (P2SH) -P2SH Addresses -Benefits of P2SH -Redeem Script and Validation -Data Recording Output (RETURN) -Time locks -Transaction Lock time (nLocktime) -Check Lock Time Verify (CLTV) -Relative time locks -Relative time locks with nSequence -Relative time locks with CSV -Median-Time-Past -Time lock Defense Against Fee Sniping-Scripts with Flow Control (Conditional Clauses) -Conditional Clauses with VERIFY Opcodes -Using Flow Control in Scripts -Complex Script Example The Bitcoin Network -Peer-to-Peer Network Architecture -Node Types and Roles -The Extended Bitcoin Network -Bitcoin Relay Networks -Network Discovery -Full Nodes -Exchanging Inventory - Simplified Payment Verification (SPV) Nodes - Bloom Filters -How Bloom Filters Work -How SPV Nodes Use Bloom Filters -SPV Nodes and Privacy - Encrypted and Authenticated Connections -Tor Transport -Peer-to-Peer Authentication and Encryption -Transaction Pools

**Module-V:****9 hrs**

**Block chain :**The Blockchain Structure of a Block -Block Header -Block Identifiers: Block Header Hash and Block Height -The Genesis Block -Linking Blocks in the Blockchain -Merkle Trees -Merkle Trees and Simplified Payment Verification (SPV) -Bitcoin Test Blockchains - Testing Playground -The Segregated Witness Testnet -The Local Blockchain - Using Test Blockchains for Development,

**Text Book(s):**

1. *Mastering Bitcoin: Programming the Open Block chain, Andreas M. Antonopoulos, Shroff/O'Reilly; Second edition, 2017.*
2. *Imran Bashir, Mastering Blockchain, Packt Publishing Limited ,2016.*

**Reference Book(s):**

1. *Arshdeep Bahga ,Blockchain Applications: A Hands-On Approach , 2017*

## CSNS823: PATTERN RECOGNITION TECHNIQUES IN CYBER CRIME

L	T	P	C
3	0	0	3

### *Pre-requisite:*

- *A good foundation of probability and linear algebra and any Machine Learning background will help.*

### *Objectives:*

- *Pattern classification algorithm for a pattern recognition problem and properly implement the algorithm using modern computing tools*
- *Clustering is an important aspect of supervised learning and has been covered extensively in this course.*
- *Cybercrime techniques and how to apply in pattern recognition.*
- *To solve real-world problems using Pattern Recognition techniques.*

### **Module-I:**

**9 hrs**

**Introduction:** Basics of pattern recognition - Design principles of pattern recognition system- Learning and adaptation- Pattern recognition approaches.

### **Module-II:**

**9 hrs**

**Classifiers Based On Bayesian Decision Theory:** Introduction-Bayesian Decision Theory- Continuous Features-Minimum error rate- classification- classifiers, discriminant functions, and decision surfaces; The normal density- Discriminant functions for the normal density- Maximum likelihood estimation-Bayesian Estimation- Bayesian parameter estimation- Gaussian Case-general theory-Hidden Markov Models.

### **Module-III:**

**9 hrs**

**Nonparametric Technique and Non-Metric Methods:** Density Estimation - Parzen Windows - K-Nearest Neighbor Estimation - Nearest Neighbor Rule- Fuzzy clustering. Non-Metric Methods- Introduction-Decision Trees- CART- Other Tree Methods- Recognition with Strings-Grammatical Methods.

### **Module-IV:**

**9 hrs**

**Malware Analysis and Network Traffic Analysis:** anomaly detection– data driven methods – feature engineering – detection with data and algorithms – challenges using ML- response and mitigation – Malware Analysis: defining – feature generation – classification - Network Traffic Analysis- Theory – ML and network security – building predictive model to classify network attack

### **Module-V:**

**9 hrs**

**Protecting consumer web and production systems:** types of abuse and data that can stop them – learning for abuse problems- large attacks - production systems - ML for system

maturity and scalability – data quality – model quality – performance – maintainability – monitoring and alerting – security and reliability – adversarial machine learning.

**Text Book(s):**

1. *Abhijit S. Theodoridis and K. Koutroumbas, “Pattern Recognition”, 4th Ed, Academic Press, 2009.*
2. *Clarence Chio David Freeman “Machine Learning and Security: Protecting Systems with Data and Algorithms”, "O'Reilly Media, Inc.", 2018*
3. *“Scene of the Cybercrime” 2nd Edition by Debra Littlejohn Shinder, Michael Cross, 2002.*
4. *Earl Gose, Richard Johnsonbaugh, Steve Jost- “Pattern Recognition and Image Analysis” - Pearson Education, 2007.*

**Reference Book(s):**

1. *Richard O. Duda, Peter E. Hart and David G. Stork, “Pattern Classification”, 2nd Edition, John Wiley, 2006.*
2. *“A Brief History of Cyber Crime” written by: R. Elizabeth C. Kitchen edited by: M.S. Smith, 2010.*

## CSNS824: CYBER LAWS AND SECURITY POLICIES

L	T	P	C
3	0	2	4

### **Pre-requisite:**

- *Familiarity with Cyber Security and Cyber Crime.*

### **Objectives:**

- *To explain the basic information on cyber security.*
- *To understand the issues those are specific to amendment rights.*
- *To have knowledge on copy right issues of software's.*
- *To understand ethical laws of computer for different countries.*

### **Module-I:**

**9 hrs**

**Introduction:** Cyber Security and its problem-Intervention Strategies: Redundancy, Diversity and Autarchy.

### **Module-II:**

**9 hrs**

**Private Ordering Solutions:** Regulation and Jurisdiction for global Cyber security - Copy Right source of risks – Pirates- Internet Infringement - Fair Use – postings - criminal liability - First Amendments - Data Losing.

### **Module-III:**

**9 hrs**

**Copy Right:** Source of risks – Trademarks – Defamation - Privacy-Common Law Privacy - Constitutional law - Federal Statutes – Anonymity - Technology expanding privacy rights

### **Module-IV:**

**9 hrs**

**Duty of Care And Ethics:** Criminal Liability - Procedural issues- Electronic Contracts & Digital Signatures- Misappropriation of information - Civil Rights, Tax, Evidence.- Legal Developments, Late 1990 to early 1966, Cyber security in Society, Security in cyber laws case studies, General Law and Cyber Law-a Swift Analysis

### **Module-V:**

**9 hrs**

**Security Policy Case Studies:** Indian National Cyber Security Policy-2013 – UK National Cyber Security Strategy 2016 to 2021 – US Cyber Security Policy

### **Text Book(s):**

1. *Jonathan Rosenoer, "Cyber Law: The law of the Internet", Springer-Verlag, 1997*
2. *Mark F Grady, Fransesco Parisi, "The Law and Economics of Cyber Security"*
3. [http://meity.gov.in/sites/upload\\_files/dit/files/National%20Cyber%20Security%20Policy%20%281%29.pdf](http://meity.gov.in/sites/upload_files/dit/files/National%20Cyber%20Security%20Policy%20%281%29.pdf)
4. [https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment\\_data/file/567242/national\\_cyber\\_security\\_strategy\\_2016.pdf](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/567242/national_cyber_security_strategy_2016.pdf)
5. <https://www.dhs.gov/topic/cybersecurity>

**Reference Book(s):**

1. *Cyber Security: Understanding Cyber Crimes, Computer Forensics And Legal Perspectives*, Sunit Belapure Nina Godbole, 2011, Wiley India Pvt Ltd

## CSNS825: INFORMATION SECURITY AND RISK MANAGEMENT

L	T	P	C
3	0	0	3

### **Pre-requisite:**

- *A broad knowledge of Information security technologies is assumed: cryptography (public key and symmetric key), firewalls, IDS, viruses/virus detection, access control, etc.*

### **Objectives:**

- *To present a system and management view of information security: what it is, what drives the requirements for information security*
- *How to integrate it into the systems design process, and life cycle security management of information systems.*

### **Module-I: 9 hrs**

**RISK I:** Identifying and categorizing risks: Risk Management – Risk Identification – Risk Assessment -Documenting the Results

### **Module-II: 9 hrs**

**RISK II:** Risk Management: Introduction – Control Strategies – Managing Risk – Feasibility and Cost Benefit Analysis – Risk Control Practices.

### **Module-III: 9 hrs**

**Security Policy:** Purpose of security policies -Enterprise Information – Issue Specific – System Specific – Guidelines

### **Module-IV: 9 hrs**

**Security Management of Deployed Systems:** Organizing For Security - Within an Organization – Components – Security Roles- Education – Training and Awareness – Security Management Models: Access Control – Architecture Models – Management Models - Benchmarking – Performance Measures.

### **Module-V: 9 hrs**

**Contingency Planning:** Fundamentals - Components: Business Impact - Incident Response - Disaster Recovery – Business Continuity - Timing and Sequence - Crisis Management - Business Resumption Planning – Testing Contingency Planning.

### **Text Book(s):**

1. *Management of Information Security by Michael E. Whitman and Herbert J. Mattord, Second edition,*

### **Reference Book(s):**

1. *Security Engineering, Ross Anderson, ISBN 978-0470068526*

## CSNS826: INTRUSION DETECTION SYSTEMS AND FIREWALL

L	T	P	C
3	0	0	3

### **Pre-requisite:**

- *Fundamental knowledge in Operating Systems and Networks*

### **Objectives:**

- *Understand when, where, how, and why to apply Intrusion Detection tools and techniques in order to improve the security posture of an enterprise.*
- *Apply knowledge of the fundamentals and history of Intrusion Detection in order to avoid common pitfalls in the creation and evaluation of new Intrusion Detection Systems*
- *Analyse intrusion detection alerts and logs to distinguish attack types from false alarms*

### **Module-I:**

**9 hrs**

**History of Intrusion Detection:** Audit, Concept and definition, Internal and external threats to data, attacks, Need and types of IDS, Information sources Host based information sources, Network based information sources.

### **Module-II:**

**9 hrs**

**Intrusion Prevention System and Snort:** Network IDs protocol based IDs, Hybrid IDs, Analysis schemes, thinking about intrusion. A model for intrusion analysis- Incident Responses – Incident Response Process – IDS ad IPS response Phases Forensics –Corporate Issues - Snort Installation Scenarios, Installing Snort, Running Snort on Multiple Network Interfaces, Snort Command Line Options. Step-By-Step Procedure to Compile and Install Snort Location of Snort Files, Snort Modes Snort Alert Modes

### **Module-III:**

**9 hrs**

**Snort Rules and ACID:** Rule Headers, Rule Options, the Snort Configuration File etc. Plugins, Preprocessors and Output Modules, Using Snort with MySQL - Using ACID and Snort Snarf with Snort -Agent development for intrusion detection - Architecture models of IDs and IPs

### **Module-IV:**

**9 hrs**

**Firewall Introduction and Technologies:** Why Internet Firewalls - Internet Services - Security Strategies - Building Firewalls - Packets and Protocols - What Does a Packet Look Like? - IP - Protocols Above IP - Protocols Below IP - Application Layer Protocols - IP Version - Non-IP Protocols - Attacks Based on Low-Level Protocol Details - Firewall Technologies - Some Firewall Definitions - Packet Filtering - Proxy Services - Network Address Translation - Virtual Private Networks

**Module-V:****9 hrs**

**Building Firewalls:** Firewall Architectures - Firewall Design - Packet Filtering - Proxy Systems - Bastion Hosts - UNIX and Linux Bastion Hosts 176 - Windows NT and Windows 2000 Bastion Hosts

**Text Book(s):**

1. *Rafeeq Rehman , “ Intrusion Detection with SNORT, Apache, MySQL, PHP and ACID,” 1st Edition, Prentice Hall , 2003.*
2. *Carl Endorf, Eugene Schultz and Jim Mellander “Intrusion Detection & Prevention”, 1st Edition, Tata McGraw-Hill, 2004.*
3. *Elizabeth D. Zwicky, Simon Cooper & D. Brent Chapman , “Building Internet Firewalls“ O’Reilly*

**Reference Book(s):**

1. *Christopher Kruegel, Fredrik Valeur, Giovanni Vigna: “Intrusion Detection and Correlation Challenges and Solutions”, 1st Edition, Springer, 2005.*
2. *Stephen Northcutt, Judy Novak : “Network Intrusion Detection”, 3<sup>rd</sup> Edition, New Riders Publishing, 2002.*
3. *T. Fahringer, R. Prodan, “A Text book on Grid Application Development and Computing Environment”. 6th Edition, Khanna Publihsers, 2012.*



## CSNS827: MULTIMEDIA SECURITY & FORENSICS

L	T	P	C
3	0	0	3

### **Pre-requisite:**

- *Basic knowledge of analysis, authentication, hiding and recovery of data.*

### **Objectives:**

- *Become knowledgeable in the concepts of various functions of operating systems*
- *Gain hands-on experience in the basic administration of a Linux system.*
- *Understand the concepts of securing operating systems.*

### **Module-I: 9 hrs**

**Digital Watermarking Basics:** Models of Watermarking - Basic Message Coding - Error Correction Coding.

### **Module-II: 9 hrs**

**Digital Watermarking and Digital Communications:** Information Theory: Mutual Information and Channel Capacity - Watermarking with Side Information - Using Perceptual Models - Robust Watermarking -Affine-Resistant Watermarking.

### **Module-III: 9 hrs**

**Media Specific Digital Watermarking:** Image Watermarking, Video Watermarking, Audio Watermarking, Watermarking for CG-models, Watermarking for Binary Images, Watermarking for 3D Contents, Data Hiding through watermarking techniques.

### **Module-IV: 9 hrs**

**Digital Watermarking Protocols:** A Buyer-Seller Watermarking Protocol, an Efficient and Anonymous Buyer-Seller Watermarking Protocol, Extensions of Watermarking Protocols, Protocols for Secure Computation.

### **Module-V: 9 hrs**

**Cryptography and Multimedia Encryption:** Introduction to Cryptography, Multimedia Processing in the Encryption Domain, Privacy preserving Information Processing, Information Theory and Digital Forensics, Forgeries Detection, New ways for making Forgeries.

### **Text Book(s):**

1. *Michael Digital Watermarking and Steganography, 2nd Edition, by Cox, Miller, Bloom, Fridrich, and Kalker, 2008*

### **Reference Book(s):**

1. *Multimedia Security Handbook, BorkoFurht, DarkoKirovski, CRC Press, 2004*
2. *Multimedia Security Technologies for Digital Rights Management, WenjunZeng, Heather Yu, Ching-Yung Lin, Elsevier, 2006*
3. *Advanced Techniques in Multimedia Watermarking: Image, Video and Audio Applications: Image, Video and Audio Applications, Al-Haj, Ali Mohammad*

4. Chin-Laung Lei, Pei-Ling Yu, Pan-Lung Tsai, and Ming-Hwa Chan. 2004. An efficient and anonymous buyer-seller watermarking protocol. *Trans. Img. Proc.* 13, 12 (December 2004)

# Software Defined Networking

L	T	P	C
3	0	2	4

**Pre-requisite:**

- *Good knowledge of computer networks.*

**Objectives:**

- *To comprehend the differences between traditional networks and software defined networks*
- *Understand advanced and emerging networking technologies*
- *Obtain skills to do advanced networking research and programming*
- *Learn how to use software programs to perform varying and complex networking tasks*
- *Expand upon the knowledge learned and apply it to solve real world problems*

**Module-I:**

**9 hrs**

**Introducing SDN:** SDN Origins and Evolution – Introduction – Why SDN? - Centralized and Distributed Controller and Data Planes - The Genesis of SDN

**Module-II:**

**9 hrs**

**SDN Abstractions:** How SDN Works - The Openflow Protocol - SDN Controllers: Introduction - General Concepts VMware - Nicira - VMware/Nicira - OpenFlow-Related - Mininet - NOX/POX - Trema - Ryu - Big Switch Networks/Floodlight - Layer 3 Centric - Plexxi - Cisco OnePK

**Module-III:**

**9 hrs**

**Programming SDN:** Network Programmability - Network Function Virtualization - NetApp Development, Network Slicing

**Module-IV:**

**9 hrs**

**Sdn Applications and Use Cases:** SDN in the Data Center - SDN in Other Environments - SDN Applications - SDN Use Cases - The Open Network Operating System 3

**Module-V:**

**9 hrs**

**SDN'S Future and Perspectives:** SDN Open Source - SDN Futures - Final Thoughts and Conclusions

**Text Book(s):**

1. *Software Defined Networks: A Comprehensive Approach* by Paul Goransson and Chuck Black, Morgan Kaufmann Publications, 2014
2. *SDN - Software Defined Networks* by Thomas D. Nadeau & Ken Gray, O'Reilly, 2013
3. *Software Defined Networking with OpenFlow* By Siamak Azodolmolky, Packt Publishing, 2013

**Reference Book(s):**

1. *Feamster, Nick, Jennifer Rexford, and Ellen Zegura. "The road to SDN: an intellectual history of programmable networks." ACM SIGCOMM Computer Communication Review 44.2 (2014): 87-98.*
2. *Kreutz, Diego, et al. "Software-defined networking: A comprehensive survey." Proceedings of the IEEE 103.1 (2015): 14-76.*
3. *Nunes, Bruno AA, et al. "A survey of software-defined networking: Past, present, and future of programmable networks." Communications Surveys & Tutorials, IEEE 16.3 (2014): 1617- 1634.*
4. *Lantz, Bob, Brandon Heller, and Nick McKeown. "A network in a laptop: rapid prototyping for software-defined networks." Proceedings of the 9th ACM SIGCOMM Workshop on Hot Topics in Networks. ACM, 2010.*
5. *Monsanto, Christopher, et al. "Composing software defined networks." Presented as part of the 10th USENIX Symposium on Networked Systems Design and Implementation (NSDI 13). 2013.*

L	T	P	C
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## CSNS832: CLOUD ORCHESTRATION AND NFV

4	0	0	4
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### **Pre-requisite:**

- Basic understanding of cloud-based services and virtualization.

### **Objectives:**

- To learn about advanced OS technologies
- To learn virtualization techniques and Cloud orchestration
- To design next generation cloud applications

### **Module-I:**

**9 hrs**

**Overview and Designing:** OpenStack Cloud architectural Consideration- Logical architecture, Nova-Compute service, Neutron-Networking Services, Architecture setup Deploying OpenStack, Cloud Controller and service.Case Studies - OpenStack – Amazon-Google – Microsoft

### **Module-II:**

**9 hrs**

**Advanced OS Technologies:** Introduction to virtualization - Xen , Hyper-V , KVM, Hardware support for virtualization - Memory virtualization (IOMMU) - Network virtualization - SR-IOV –VMQ – Advance Networking(SDN and NFV)

### **Module-III:**

**9 hrs**

**Operating the Cloud Infrastructure:** HA and Failover - Monitoring and troubleshooting - Performance tuning Maintaining Cloud Performance. Cloud Protocols - Representational state transfer REST - Web Server Gateway Interface (WSGI)

### **Module-IV:**

**9 hrs**

**Network Function Virtualization(NFV):**Virtualization Concepts - NFV Architecture framework - benefits of NFV - Virtualization of network functions -CAP theory - Replication Vs. Erasure coding - Consistent hashing - Case Studies - Swift - Hadoop Distributed File System (HDFS) Vs. Amazon’s Simple Storage Service (S3)

### **Module-V:**

**9 hrs**

**NFV deployment in the Cloud-Orchestrating-** Deploying and Managing NFV Infrastructure - Network services - Software Defined Networking (SDN)

### **Text Book(s):**

1. *Mastering OpenStack*, Chandan Duttan Chawdhury, PACKT Publishing 2017
2. *Adnan Ahmed Siddiqui - OpenStack Orchestration*, PACKT Publishing 2015
3. *Network Functions Virtualization (NFV) with a Touch of SDN Paperback*, Rajendra Chayapathi , Syed F.Hassan , Paresh Shah, Addison Wesley , November 2016.

### **Reference Book(s):**

1. *Qiang Duan , Mehmet Toy, “Virtualized Software-Defined Networks and Services”* , Artech House, 2016.

## CSNS833: SOFTWARE DEFINED OPTICAL NETWORKS

L	T	P	C
3	0	0	3

**Pre-requisite:**

- Basic understanding of SDN.

**Objectives:**

- To acquire knowledge of Optical networks and its basic principles
- To acquire knowledge of SDN and its application areas
- To learn the use of SDN in Optical network environments and its applications

**Module-I:**

**9 hrs**

**Fundamentals of SDN:** SDN Operation - SDN Devices - SDN Controller - The OpenFlow Specification -OpenFlow Overview -OpenFlow 1.0 and OpenFlow Basics -OpenFlow .1 Additions -OpenFlow 1.2 Additions -OpenFlow 1.3 Additions -OpenFlow Limitations - Alternative Definitions of SDN - Potential Drawbacks of Open SDN - SDN via APIs - SDN via Hypervisor-Based Overlays - SDN via Opening Up the Device - Network Functions Virtualization - Alternatives Overlap and Ranking

**Module-II:**

**9 hrs**

**Optical Networks Technology:** Propagation of Signals in Optical Fiber - Components - Modulation and Demodulation - Transmission System Engineering - Evolution from Wavelength-Switched to Flex-Grid Optical Networks - Taking Advantage of Elastic Optical Networks - Routing and Spectrum Allocation - Transmission in Elastic Optical networks

**Module-III:**

**9 hrs**

**SDN in Other Environments:** Wide Area Networks - Service Provider and Carrier Networks - Campus Networks - Hospitality Networks - Mobile Networks - In-Line Network Functions - Optical Networks - SDN vs. P2P/Overlay Networks

**Module-IV:**

**9 hrs**

**SDN in Optical Networks and Management:** Client Layers of the Optical Layer - WDM Network Elements - WDM Network Design - Control and Management - Access Networks - Photonic Packet Switching - Node Architectures for Elastic and Flexible optical networks - Sliceable bandwidth variable transponders - GMPLS Control Plane - SDN in Optical networks - Application based network operations - In-Operation network Planning

**Module-V:**

**9 hrs**

**Case Studies in Software Defined Optical Networks:** Review the latest development like A Software -Defined optical Network emulation platform (SONEP) - S-BVT Based HYDRA - SDN Space Division Multiplexing (SDM) in optical networks - ROLEX version with centralized SDN - OpenFlow enabled restoration in EONs

**Text Book(s):**

1. Paul Goransson Chuck Black, "Software Defined Networks", 1<sup>st</sup> Edition, A Comprehensive Approach, Morgan Kaufmann, 2014.

2. *Victor Lopez, Luis Velasco, "Elastic Optical Networks: Architectures, Technologies and Control". Optical Network series, Springer International Publications, 2016.*

**Journal / Paper(s):**

1. <https://www.osapublishing.org/jocn/home.cfm>
2. [https://www.researchgate.net/publication/283986398\\_Software\\_Defined\\_Optical\\_Networks\\_SDONs\\_A\\_Comprehensive\\_Survey](https://www.researchgate.net/publication/283986398_Software_Defined_Optical_Networks_SDONs_A_Comprehensive_Survey)

**Reference Book(s):**

1. *Rajiv Ramaswami, Kumar Sivarajan, Galen Sasaki, "Optical Networks, A Practical Perspective, 3<sup>rd</sup> Edition", Morgan Kaufmann, 2009.*
2. *Wei Wei, Jianjun Yu, "Software-defined Optical Communications and Networking: Principles and Applications", Taylor and Francis, CRC Press, 2017.*
3. *Paul Goransson Chuck Black Timothy Culver, Software Defined Networks , 2<sup>nd</sup> Edition, A Comprehensive Approach , eBook ISBN: 9780128045794*

## CSNS834: SDN FOR REAL NETWORKS

L	T	P	C
3	0	0	3

### **Pre-requisite:**

- *Basic understanding of SDN and familiarity with modern networking technologies.*

### **Objectives:**

- *To learn techniques to migrate legacy networks towards SDN*
- *To apply SDN techniques for converging wired and wireless networks*

### **Module-I:**

**9 hrs**

**Software-Defined Networking:** Software Defined Networking– The Basics-SDN Controllers-A Little History about SDN Controller Platforms-Open Daylight SDN Controllers-What is Open SDN?- SDN in the data center: Sustainable support for tomorrow's applications-Benefits that SDN offers in the data center.

### **Module-II:**

**9 hrs**

**Software Defined Networking For Cloud Computing:** Applying Software-defined Networks to Cloud Computing Cloud Computing and Network Virtualization-. Software-defined Networks (SDNs)- Cloud Network Virtualization using SDN Case Study with Open Daylight and Open Stack- Final Considerations, Challenges and Perspectives

### **Module-III:**

**9 hrs**

**Software Defined Networking For Internet-Of-Things:** Why SDN for the IoT? -SDN—Simplicity for the IoT-SDN architecture for IoT - SDN—Scalability for the IoT-SDN—Traffic Flow Optimization for the IoT-Security and Connectivity- The Telco Role

### **Module-IV:**

**9 hrs**

**SDN For Artificial Intelligence:** What is Artificial Intelligence?-Artificial Intelligence in SDN- Load Balance and Flow Routing Network Security- Intelligent Network Applications.

### **Module-V:**

**9 hrs**

**SDN For The 5G Networks:** Introduction- Evolution of the Wireless Communication towards the 5G- Network Function Virtualization- Information-Centric Networking- Mobile and Wireless Networks- Ubiquitous Connectivity- Mobile Clouds- Cooperative Cellular Networks- Unification of the control plane-Supporting automatic QoS provisioning- Cognitive Network Management and Operation- Role of Satellites in the 5G networks

### **Text Book(s):**

1. *SDN and NFV Simplified: A Visual Guide to Understanding Software Defined Networks and Network Function Virtualization 1st Edition by Jim Doherty*
2. *Software-Defined Networking (SDN) with OpenStack By Sriram Subramanian, Sreenivas Voruganti, Packt 2016*
3. *Network Function Virtualization: Concepts and Applicability in 5G Networks By Ying Zhang, John Wiley and Sons 2018*



4. *Building the Network of the Future: Getting Smarter, Faster, and More ...* edited by John Donovan, KrishPrabhu
5. *Internet of Things for Architects: Architecting IoT solutions* by Perry Lea, Packt publishing 2018
6. *“Foundations of Modern Networking: SDN, NFV, QoE, IoT, and Cloud”* William Stallings Publisher: Addison-Wesley 2015 ISBN: 9780134175393

**Reference Book(s):**

1. <https://www.sdxcentral.com/sdn/definitions/software-defined-networking-tutorial/>
2. <http://sbrc2015.ufes.br/wp-content/uploads/Ch1.pdf>.
3. *Cloud Services, Networking, and Management* By Nelson Fonseca, Raouf Boutaba IEEE Press Wiley 2015.
4. *IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the IoT* By David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry CISCO Press

## CSNS835: SOFTWARE DEFINED RADIOS

L	T	P	C
3	0	0	3

### *Pre-requisite:*

- *Advanced Networks And Communication Systems*

### *Objectives:*

- *Understand the principles behind the Software Defined Radios over the conventional Cognitive Radios.*
- *Ability to analyse Software Defined Networking protocols and cognitive radio techniques*
- *Understand the data traversal over SDN*
- *Design algorithms for Software Defined Radio and cognitive radio environments*

### **Module-I:**

**9 hrs**

**Software Defined Radio Concepts:** Need for Software Radios - Characteristics and Benefits of a Software Radio - Design Principles of a Software Radio - RF Receiver Front-End Topologies - Importance of the Components to Overall Performance - Transmitter Architectures and Their Issues - Noise and Distortion in the RF Chain ADC and DAC Distortion - Flexible RF Systems

### **Module-II:**

**9 hrs**

**SDN As A Platform For Cognitive Radio:** Hardware Architecture: Baseband Processors - Hardware Architecture: Multi-Core Systems - Software Architecture: Design Philosophies - GNU Radio - Software Communications Architecture - Application Software - Component Development - Waveform Development – Cognitive Waveform Development

### **Module-III:**

**9 hrs**

**Cognitive Radio- Technologies Required:** Software Capable Radios - Software Programmable Radios - SDR Examples - Aware Adaptive and CRs - Radio Capabilities and Properties Comparison - Spectrum Awareness and Frequency Occupancy - Software Technology - Funding and Researches in CRs - Directions and Standards

### **Module-IV:**

**9 hrs**

**Object Oriented Representation Of Radios:** Introduction to Network Resources - Network Resources - Object Oriented Programming – Object Request Broker Architecture - Object Brokers and Software Radios - Mobile Application Environments - Security in Software Radios - Joint Tactical Radio Systems - SCA Architectures

### **Module-V:**

**9 hrs**

**Case Studies In Software Radio Designs:** Intrinsic Architectural Characteristics to Software Radios - Important Architectural Characteristics to Software Radios - Practical Software Radios - CA Architectural Details - Wireless Information Transfer Systems - SDR Digital

Transceiver Sub Systems - Spectrum ware Systems - Layered Radio Architecture - Case Study on Trending Software-Defined Radio Architecture

**Text Book(s):**

1. *Software Radio: A Modern Approach to Radio Engineering* By Jeffrey
2. *Cognitive Radio Technology*”, Bruce A Fette, Academic Press, 2009

**Reference Book(s):**

1. *Cognitive Radio Networks* by Wyglinski, Alexander M. Nekovee, Maziar, Hou, Y. Thomas, 2010 Elsevier.

# Internet of Things

## CSNS841: INTERNET - of -THINGS (IOT)

L	T	P	C
3	0	0	3

### **Pre-requisite:**

- *Understanding of computer networks and Cloud computing.*

### **Objectives:**

- *Understand basics of IOT*
- *Discuss IoT Enablers And Solutions*
- *To Understand the Reliability, Security, And Privacy Of Iot*
- *Have a brief study on the IoT Applications*

### **Module-I:**

**9 hrs**

**Background:** An Overview – evolution – architectures – resource management - data management and analytics – communication – security – identity management – Privacy - Standardization and Regulatory Limitations - Open Source Semantic Web Infrastructure for Managing IoT Resources in the Cloud - OpenIoT Architecture for IoT/Cloud Convergence - Scheduling Process and IoT Services Lifecycle- Scheduling and Resource Management - Validating Applications and Use Cases- Future Research Directions - Device/Cloud Collaboration Framework- Applications of Device/Cloud Collaboration

### **Module-II:**

**9 hrs**

**IoT Enablers and Solutions:** Programming Frameworks for Internet of Things - Embedded Device Programming Languages -Message Passing in Devices - Coordination Languages - Polyglot Programming - IoT Programming Approaches - Existing IoT Frameworks - Future Research Directions -Virtualization on Embedded Boards as Enabling Technology for the Cloud of Things - ARM Virtualization Extensions - XEN ARM Virtualization - KVM ARM Virtualization- Container-Based Virtualization - Virtualization and Real-Time - Micro Virtual Machines (MicroVMs) for Cloud-Assisted Cyber-Physical Systems (CPS) -Virtual Machines and Micro Virtual Machines - Other Architectures - Architecture for Deploying CPS in the Cloud and the Expansion of the IoT - Extending the Possibilities of the IoT by Cloud Computing - Micro Virtual Machines with the Sensor Observation Service - the Path Between Smart Objects and CPS - Virtual Machines and Sensor Observation Service – Implementation - IoT Architecture for Selected Use Cases

### **Module-III:**

**9 hrs**

**IoT Data and Knowledge Management:** Stream Processing in IoT, Foundations, State-of-the-Art and Future Directions -The Foundations of Stream Processing in IoT - Continuous Logic Processing System - Challenges and Future Directions - A Framework for Distributed Data Analysis for IoT

### **Module-IV:**

**9 hrs**

**IoT Reliability, Security, and Privacy:** Security and Privacy in the Internet of Things - IoT Security Overview - Security Frameworks for IoT - Internet of Things—Robustness and Reliability – Introduction- IoT Characteristics and Reliability Issues - Addressing Reliability

- Governing Internet of Things: Issues, Approaches, and New Paradigms - Background and Related Work - IoT Governance - Future Research Directions - TinyTO: Two-Way Authentication for Constrained - Devices in the Internet of Things – Introduction - Security Aspects and Solutions - Design Decisions - TinyTO Protocol - Possible Handshake Protocol Candidates – Evaluation - Obfuscation and Diversification for Securing - the Internet of Things (IoT) – Introduction - Distinguishing Characteristics of IoT - Obfuscation and Diversification Techniques - Enhancing the Security in IoT Using Obfuscation - and Diversification Techniques

**Module-V:**

**9 hrs**

**IoT Applications:** Applied Internet of Things – Scenario - Architecture Overview -Sensor to Gateway Communication – Sensors - The Gateway Hardware - Gateway Software - Data Transmission- Internet of Vehicles and Applications - Background and Concept - Network Architecture - Characteristics and Challenges - Enabling Technologies –Applications - Summary and Future Directions - Cloud-Based Smart-Facilities Management - Background and Related Work - Middleware Services Resource Management Techniques for Wireless Sensor Networks - Sensor Allocation - Request Scheduling -Resource Management Techniques for Supporting Data Analytics

**Text Book(s):**

1. Rajkumar Buyya, Amir Vahid Dastjerdi, “Internet of Things: Principles and Paradigms”, Elsevier 2016

**Reference Book(s):**

1. Jerome Henry, “IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things”, Cisco Press, 2017

## CSNS842: IoT ARCHITECTURE AND PROTOCOLS

L	T	P	C
3	0	0	3

### **Pre-requisite:**

- *Networking Basics: TCP, UDP, TCP/IP and OSI Model.*

### **Objectives:**

- *To Understand the Architectural Overview of IoT*
- *To Understand the IoT Reference Architecture and Real World Design Constraints*
- *To Understand the various IoT Protocols ( Datalink, Network, Transport, Session, Service)*

### **Module-I:**

**9 hrs**

**Overview:** IoT-An Architectural Overview– Building An Architecture - Main Design Principles And Needed Capabilities - An Iot Architecture Outline - Standards Considerations. M2M and IoT Technology Fundamentals- Devices And Gateways - Local And Wide Area Networking - Data Management - Business Processes in IoT - Everything as a Service(XaaS) - M2M and IoT Analytics - Knowledge Management

### **Module-II:**

**9 hrs**

**Reference Architecture:** 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. Real-World Design Constraints- Introduction - Technical Design Constraints-Hardware Is Popular Again - Data Representation And Visualization - Interaction And Remote Control.

### **Module-III:**

**9 hrs**

**IOT Data Link Layer & 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

### **Module-IV:**

**9 hrs**

**Transport & Session Layer Protocols:** Transport Layer (TCP - MPTCP - UDP - DCCP - SCTP)-(TLS - DTLS) – Session Layer-HTTP -CoAP - XMPP - AMQP - MQTT

### **Module-V:**

**9 hrs**

**Service Layer Protocols & Security:** Service Layer - oneM2M - ETSI M2M - OMA - BBF – Security in IoT Protocols – MAC 802.15.4 - 6LoWPAN - RPL - Application Layer

### **Text Book(s):**

1. *Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle, “From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence”, 1<sup>st</sup> Edition, Academic Press, 2014.*

**Reference Book(s):**

1. *Peter Waher, "Learning Internet of Things", PACKT publishing, BIRMINGHAM – MUMBAI*
2. *Bernd Scholz-Reiter, Florian Michahelles, "Architecting the Internet of Things",*
3. *Daniel Minoli, "Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications",*
4. *Vijay Madisetti and Arshdeep Bahga, "Internet of Things (A Hands-on Approach)", 1st Edition, VPT, 2014.*



## CSNS843: EMBEDDED SYSTEMS

L	T	P	C
3	0	0	3

### **Pre-requisite:**

- *Good understanding of the concepts of basic electronics such as circuits, logic gates.*

### **Objectives:**

- *To understand the architecture and functions of 8085 processor*
- *To Learn Assembly language programming*
- *To understand the Basic concepts of Embedded systems and 8051 microcontroller*
- *To gain knowledge about how the I/O devices are interfaced with 8051 microcontroller*
- *To understand the basics of RTOS and to learn the method of designing a real time systems*

### **Module-I:**

**9 hrs**

**Introduction To Microprocessors:** Evolution Of Microprocessors - 8-Bit Processor - 8085 Architecture – Register Organization - Instruction Set – Timing Diagram- Addressing Modes – Interrupts- Interrupt Service Routines- Assembly Language Programming Using 8085

### **Module-II:**

**9 hrs**

**Introduction To Embedded Systems:** Embedded Systems- Processor Embedded Into A System-Embedded Hardware And Software Units- Applications-Design Process – Intel 8051 Architecture- Processor And Memory Organization - Interrupts Of 8051 - Assembly Language Programming Using 8051

### **Module-III:**

**9 hrs**

**Interfacing With 8051:** Input-Output Interfacing – Bus Standards – PCI – ISA – Timing And Control – Input Output Devices – Serial and Parallel Communication – Motor Control- Programming Display Devices – ARM

### **Module-IV:**

**9 hrs**

**Real – Time Operating System:** Inter Process Communication – Signal Functions – Socket Programming – Mailbox - Pipes – RTOS – OS Services – Process Management - Timer Function –Event Function – Memory Management – Device, Files And I/O Subsystem – Basic Design Of RTOS.

### **Module-V:**

**9 hrs**

**RTOS Programming:** Basic Functions – Types of RTOS – RTOS mCOS – RTLinux – Real Time Linux Functions- Programming with RTLinux – Case Study

### **Text Book(s):**

1. *Rajkamal, “Embedded System: Architecture, Programming and Design” Tata Mcgraw-Hill Education, Second Edition, 2008.*
2. *B.Kanth Rao, “Embedded Systems” PHI Learning Private Limited, 2011.*

3. *Mohamed Rafiquzzaman, "Microprocessors and Microcomputer-based system design", CRC Press, Second Edition, 2013*

**Reference Book(s):**

1. *Marilyn Wolf, "Computers as a Component" Third Edition, Morgan Kaufmann Series 2012.*
2. *A.P.Godse & A.O.Mulani" Embedded Systems" Third Edition, Technical publications 2009.*

## CSNS844: PRIVACY AND SECURITY IN IoT

L	T	P	C
3	0	0	3

### **Pre-requisite:**

- *Basic understanding of IoT Architecture And Protocols*

### **Objectives:**

- *Ability to understand the Security requirements in IoT and to understand the cryptographic fundamentals for IoT.*
- *Ability to understand the authentication credentials and access control.*
- *Understand the various types Trust models and Cloud Security.*

### **Module-I:**

**9 hrs**

**Introduction: Securing The Internet of Things:** Security Requirements in IoT Architecture - Security in Enabling Technologies - Security Concerns in IoT Applications - Security Architecture in the Internet of Things - Security Requirements in IoT – Insufficient Authentication/Authorization - Insecure Access Control - Threats to Access Control, Privacy, and Availability - Attacks Specific to IoT. Vulnerabilities – Secrecy and Secret-Key Capacity - Authentication/Authorization for Smart Devices - Transport Encryption – Attack & Fault trees

### **Module-II:**

**9 hrs**

**Cryptographic Fundamentals For IOT:** Cryptographic primitives and its role in IoT – Encryption and Decryption – Hashes – Digital Signatures – Random number generation – Cipher suites – key management fundamentals – cryptographic controls built into IoT messaging and communication protocols – IoT Node Authentication

### **Module-III:**

**9 hrs**

**Identity & Access Management Solutions For IOT:** Identity lifecycle – authentication credentials – IoT IAM infrastructure – Authorization with Publish / Subscribe schemes – access control

### **Module-IV:**

**9 hrs**

**Privacy Preservation and Trust Models For IOT:** Concerns in data dissemination – Lightweight and robust schemes for Privacy protection – Trust and Trust models for IoT – self-organizingThings - Preventing unauthorized access.

### **Module-V:**

**9 hrs**

**Cloud Security For IOT:** Cloud services and IoT – offerings related to IoT from cloud service providers – Cloud IoT security controls – Enterprise IoT cloud security architecture – New directions in cloud enabled IoT computing

### **Text Book(s):**

1. *Practical Internet of Things Security by Brian Russell, Drew Van Duren*

**Reference Book(s):**

1. *Securing the Internet of Things Elsevier*
2. *Security and Privacy in Internet of Things (IoTs): Models, Algorithms, and Implementations*

## SNS845: BIG DATA ANALYTICS FOR IoT

L	T	P	C
3	0	0	3

### **Pre-requisite:**

- *Basic understanding of big data and IoT.*

### **Objectives:**

- *To learn the concepts of big data analytics*
- *To learn the concepts about Internet of things*
- *To understand and implement smart systems*

### **Module-I:**

**9 hrs**

**Big Data Platforms For The Internet Of Things:** Big Data Platforms for the Internet of Things: network protocol- data dissemination –current state of art- Improving Data and Service Interoperability with Structure, Compliance, Conformance and Context Awareness: interoperability problem in the IoT context- Big Data Management Systems for the Exploitation of Pervasive Environments – Big Data challenges and requirements coming from different Smart City applications

### **Module-II:**

**9 hrs**

**RFID False Authentications:** On RFID False Authentications: YA TRAP – Necessary and sufficient condition for false authentication prevention - Adaptive Pipelined Neural Network Structure in Self-aware Internet of Things: self-healing systems, Role of adaptive neural network- Spatial Dimensions of Big Data: Application of Geographical Concepts and Spatial Technology to the Internet of Things- Applying spatial relationships, functions, and models

### **Module-III:**

**9 hrs**

**Big Data Management:** A Platform for Internet of Things and Analytics: a massively distributed number of sources - Big Data Metadata Management in Smart Grids: semantic inconsistencies – role of metadata

### **Module-IV:**

**9 hrs**

**Web Enhanced Building:** Toward Web Enhanced Building Automation Systems: heterogeneity between existing installations and native IP devices - loosely-coupled Web protocol stack –energy saving in smart building- Intelligent Transportation Systems and Wireless Access in Vehicular Environment Technology for Developing Smart Cities: advantages and achievements- Emerging Technologies in Health Information Systems: Genomics Driven Wellness Tracking and Management System (GO-WELL) – predictive care – personalized medicine

### **Module-V:**

**9 hrs**

**Sustainability Data and Analytics:** Sustainability Data and Analytics in Cloud-Based M2M Systems – potential stakeholders and their complex relationships to data and analytics applications - Social Networking Analysis - Building a useful understanding of a social

network - Leveraging Social Media and IoT to Bootstrap Smart Environments : lightweight  
Cyber Physical Social Systems – citizen actuation

**Text Book(s):**

1. *NikBessis, CiprianDobre, Big Data and Internet of Things: A Roadmap for Smart Environments*
2. *Stackowiak, R., Licht, A., Mantha, V., Nagode, L.,” Big Data and the Internet of Things Enterprise Information Architecture for A New Age”, A press, 2015.*

**Reference Book(s):**

1. *John Bates, “Thingalytics - Smart Big Data Analytics for the Internet of Things”, John Bates, Software AG; 1 edition 2015.*

## CSNS846: FOG COMPUTING

L	T	P	C
3	0	0	3

### **Pre-requisite:**

- *Basic understanding of cloud computing*

### **Objectives:**

- *Become familiar with the concepts of Fog*
- *Understand the architecture and its components and working of components and its performance*
- *Explore Fog on security, multimedia and smart data*
- *Model the fog computing scenario*

### **Module-I:**

**9 hrs**

**Introduction To Fog Computing:** Characteristics of the Fog Layer - Design and Organization – Services - Computing Services- Storage Services- Communication Services.

### **Module-II:**

**9 hrs**

**Management At The Fog Layer:** IoT Resource Estimation Challenges and Modelling in Fog: Fog Computing - Resource Estimation and Its Challenges - Customer's Reliability-Based Dynamic Resource Estimation in Fog - Fog Computing in Support of Hierarchical Emergent Behaviours - Fog Computing - Hierarchical Emergent Behaviours - Autonomous Vehicles Primitives

### **Module-III:**

**9 hrs**

**Services Of The Fog Layer:** Privacy-Preserving Computation in Fog Computing – Blockchain - Multi-Party Computation - Multi-Party Computation and Blockchain

### **Module-IV:**

**9 hrs**

**Self-Aware Fog:** Cloud, Fog, and Mist Computing Networks - Self-Aware Data Processing – Case Studies I,II,III and IV - Requirements and Architecture for a Smart Gateway Based on Hierarchical Temporal Memory - Urban IoT Edge Analytics - Design Challenges - Edge-Assisted Architecture

### **Module-V:**

**9 hrs**

**Control-As-A-Service Andcase Study:** Power Grid and Energy Management - Cyber-Physical Energy Systems - Internet-of-Things and Fog Computing - Control-as-a-Service - Residential Cyber-Physical Energy System - Healthcare Services in the Fog Layer - System Architecture of Healthcare IoT - Case Study, Experiments, and Evaluation -Edge Architectures - Edge Computing Applications

### **Text Book(s):**

- 1 *Amir M. Rahmani , Fog Computing in the Internet of Things Intelligence at the Edge*
- 2 *Fog Computing: Helping the Internet of Things Realize its Potential Amir Vahid Dastjerdi and Rajkumar Buyya, University of Melbourne*

- 3 *Multi-Dimensional payment Plan in Fog Computing with Moral Hazard, Yanru Zhang, Nguyen H. Tran, Dusit Niyato, and Zhu Han, IEEE, 2016*

**Reference Book(s):**

- 1 *Farhoud Hosseinpour, Juha Plosila, Hannu Tenhunen, "An Approach for Smart management of Big Data in the Fog Computing Context", IEEE 8th International Conference on Cloud Computing Technology and Science, 2016*
- 2 *Hua-Jun Hong, Jo-Chi Chuang and Cheng-Hsin Hsu, "Animation Rendering on Multimedia Fog computing Platforms", IEEE 8th International Conference on Cloud Computing Technology and Science, 2016*
- 3 *Dongyoung Koo, Youngjoo Shin, Joobeom Yun, Junbeom Hur, "A Hybrid deduplication for secure and Efficient data Outsourcing in Fog Computing", IEEE 8th International Conference on Cloud Computing Technology and Science, 2016*
- 4 *Fog Computing: A Platform for Internet of Things and Analytics, Flavio Bonomi, Rodolfo Milito, Preethi Natarajan and Jiang Zhu, Big Data and Internet of Things: A Roadmap for Smart Environments, Studies in Computational Intelligence 546, DOI: 10.1007/978-3-319-05029-4\_7, ©Springer International Publishing Switzerland 2014*
- 5 *CloudPath: A Multi-Tier Cloud Computing Framework*
- 6 *Cloud4Home -- Enhancing Data Services with @Home Clouds*
- 7 *Femto Clouds: Leveraging Mobile Devices to Provide Cloud Service at the Edge*
- 8 *Fast, Scalable and Secure Onloading of Edge Functions Using AirBox*



## CSNS847: WIRELESS SENSOR PROTOCOLS & PROGRAMMING

L	T	P	C
3	0	0	3

### **Pre-requisite:**

- *Understanding of OSI model.*

### **Objectives:**

- *Understand basic sensor network concepts*
- *Know physical layer issues, understand and analyse Medium Access Control Protocols*
- *Comprehend network and transport layer characteristics and protocols and implement conventional protocols*
- *Understand the network management and Middleware services*

### **Module-I:**

**9 hrs**

**Background Of Sensor Network Technology:** Basic Overview of the Technology- Basic Sensor Network Architectural Elements - Applications of Wireless Sensor Networks: Range of Applications- Examples of Category 2 WSN - Examples of Category - Another Taxonomy of WSN Technology- Basic Wireless Sensor Technology - Sensor Node Technology- Hardware and Software - Sensor Taxonomy- WN Operating Environment- WN Trends

### **Module-II:**

**9 hrs**

**Wireless Transmission Technology and Systems:** Radio Technology Primer -Medium Access Control Protocols for Wireless Sensor Networks- Background - MAC Protocols for WSNs- Sensor-MAC Case Study- Routing Protocols for Wireless

### **Module-III:**

**9 hrs**

**Sensor Networks:** Data Dissemination and Gathering- Routing Challenges and Design Issues in Wireless Sensor Networks- Routing Strategies in Wireless Sensor Networks- Transport Control Protocols for Wireless Sensor Networks- Traditional Transport Control Protocols- Transport Protocol Design Issues - Examples of Existing Transport Control Protocols- Performance of Transport Control Protocols

### **Module-IV:**

**9 hrs**

**Middleware For Wireless Sensor Networks:** WSN Middleware Principles - Middleware Architecture- Data-Related Functions –Architectures - Existing Middleware- MiLAN (Middleware Linking Applications and Networks - Network Management for Wireless Sensor Networks - Network Management Requirements - Network Management Design Issues - Example of Management Architecture: MANNA - Other Issues Related to Network Management

### **Module-V:**

**9 hrs**

**OS For Wireless Sensor Networks:** Introduction - Operating System Design Issues - Examples of Operating Systems- Performance and Traffic Management – Background -

## WSN Design Issues - Performance Modeling of WSNs - Case Study: Simple Computation of the System Life Span

### **Text Book(s):**

1. *KazemSohraby, Daniel manoli , “Wireless Sensor networks- Technology,Protocols and Applications”, Wiley InterScience Publications 2010*
2. *WaltenegusDargie, Christian Poellabauer , “Fundamentals of Wireless Sensor Networks, Theory and Practice”, Wiley Series on wireless Communication and Mobile Computing, 2011*

### **Reference Book(s):**

1. *Bhaskar Krishnamachari , “ Networking Wireless Sensors”, Cambridge University Press, 2005*
2. *C.S Raghavendra, Krishna M.Sivalingam, Taiebznati , “Wireless Sensor Networks”, Springer Science 2004*

# **Wireless Computing**

## CSNS851: RADIO NETWORK PLANNING & OPTIMIZATION

L	T	P	C
3	0	0	3

### **Pre-requisite:**

- *Understanding of Multiple Radio Access Techniques for Wireless Communication.*

### **Objectives:**

- *To understand Radio Network Planning & Optimization.*
- *To provide detailed descriptions of the radio network planning and optimization of UMTS networks based on Frequency Division Duplex (FDD) WCDMA technology.*

### **Module-I:**

**9 hrs**

**Introduction:** Introduction to Radio Network Planning and Optimization - Future Trends - Towards a Service driven Network Management - Wireless Local Area Networks (WLANs) - Next-generation Mobile Communication

### **Module-II:**

**9 hrs**

**WCDMA Radio Network Planning:** Dimensioning - Detailed Planning - Verification of Dimensioning with Static Simulations - Verification of Static Simulator with Dynamic Simulations - Optimization of the Radio Network Plan

### **Module-III:**

**9 hrs**

**Steganalysis WCDMA–GSM Co-planning Issues:** Radio Frequency Issues - Radio Network Planning Issues; Coverage and Capacity Enhancement Methods - Techniques for Improving Coverage - Techniques for Improving Capacity

### **Module-IV:**

**9 hrs**

**Radio Resource Utilization:** Introduction to Radio Resource Management - Power Control - Handover Control - Congestion Control - Resource Management; RRU for High-speed-Downlink Packet Access (HSDPA) - Impact of Radio Resource Utilization on Network Performance.

### **Module-V:**

**9 hrs**

**Radio Network Optimization Process:** Introduction to Radio Network Optimization Requirements - Introduction to the Telecom Management Network Model - Tools in Optimization - Advanced Analysis Methods and Radio Access Network Autotuning – Advanced Analysis Methods for Cellular Networks - Automatic Optimization..

### **Text Book(s):**

1. *“Radio Network Planning and Optimization”, Edited by Jaana Laiho, Achim Wacker & Tomas Novosad, John Wiley, 2006.*
2. Morten Tolstrup, *“Indoor Radio Planning: A Practical Guide for GSM, DCS, UMTS and HSPA”, John Wiley, 2008.*

### **Reference Book(s):**

1. *Iana Siomina, “Radio Network Planning and Resource Optimization”, Printed by LiU Tryck, Linköping, Sweden, 2007.*

## CSNS852: ADVANCED WIRELESS TECHNOLOGIES

L	T	P	C
3	0	0	3

### **Pre-requisite:**

- *Good knowledge of fundamentals of computer networks is required.*

### **Objectives:**

- *To build an understanding of the fundamental concepts of wireless networking.*
- *To familiarize with the basic taxonomy and terminology of the various channel modelling and layers of the network.*
- *To get introduced to resource management and security issues in wireless networks.*
- *To gain expertise in some specific areas of networking such as Ad Hoc networks, sensors networks, and active networks.*

### **Module-I:**

**9 hrs**

**Adaptive and Reconfigurable Link Layer:** Link Layer Capacity of Adaptive Air Interfaces - Adaptive Transmission in Ad Hoc Networks - Adaptive Hybrid ARQ Schemes for Wireless Links - Stochastic Learning Link Layer Protocol - Adaptive Medium Access Control

### **Module-II:**

**9 hrs**

**Adaptive Network and TCP Layer:** Graphs and Routing Protocols - Graph Theory - Routing with Topology Aggregation - Network and Aggregation Models - Effective Capacity - TCP Operation and Performance - TCP for Mobile Cellular Networks - Random Early Detection Gateways for Congestion Avoidance TCP for Mobile Ad Hoc Networks.

### **Module-III:**

**9 hrs**

**Mobility and Resource Management:** Prioritized Handoff - Cell Residing Time Distribution - Mobility Prediction in Pico- and Micro-Cellular Networks - Channel Assignment Schemes - Resource Management in 4G.

### **Module-IV:**

**9 hrs**

**Security:** Authentication - Security Architecture - Security Management in GSM Networks - Security Management in UMTS - Security Architecture for UMTS/WLAN Interworking - Security in Ad Hoc Networks - Security in Sensor Networks.

### **Module-V:**

**9 hrs**

**Ad Hoc and Sensor Networks:** Routing Protocols - Hybrid Routing Protocol - Scalable Routing Strategies - Multipath Routing - Clustering Protocols. Caching Schemes for Routing - Distributed QoS Routing - Sensor Networks Parameters - Sensor Networks Architecture - Mobile Sensor Networks Deployment - Directed Diffusion

### **Text Book(s):**

1. *Glisic, Savo G., Advanced Wireless Networks, John Wiley and Sons, 2006.*
2. *Chen, Hsiao-Hwa and Guizani, Mohsen, Next Generation Wireless Systems and Networks, John Wiley and Sons (2006).*

**Reference Book(s):**

1. *Glisic, Savo G., Advanced Wireless Networks, John Wiley and Sons, 2006.*
2. *Rappaport, T.S., Wireless Communications: Principles and Practice, 2e, 2010.*

## CSNS853: MOBILE COMMUNICATION NETWORKS

L	T	P	C
3	0	0	3

### **Pre-requisite:**

- *Basic understanding of wireless transmissions and computer networks.*

### **Objectives:**

- *To understand the issues involved in mobile communication system design and analysis..*
- *To understand the concept of frequency reuse. To understand the characteristics of wireless channels.*
- *To acquire knowledge in different modulation schemes and its error probability in wireless system.*
- *To know the fundamental limits on the capacity of wireless channels.*
- *To understand the diversity concepts.*

### **Module-I:**

**9 hrs**

**The Wireless Channel:** Overview of wireless systems – Physical modeling for wireless channels – Time and Frequency coherence – Statistical channel models – Capacity of wireless Channel- Capacity of Flat Fading Channel — Channel Distribution Information known – Channel Side Information at Receiver – Channel Side Information at Transmitter and Receiver – Capacity with Receiver diversity – Capacity comparisons – Capacity of Frequency Selective Fading channels

### **Module-II:**

**9 hrs**

**Digital Modulation:** Digital Modulation and Detection-Fading– Outage Probability– Average Probability of Error — Combined Outage and Average Error Probability – Doppler Spread – Inter symbol Interference

### **Module-III:**

**9 hrs**

**Multiantenna Communication:** Realization of Independent Fading Paths – Receiver Diversity – Selection Combining – Threshold Combining – Maximal-Ratio Combining – Equal - Gain Combining – Transmitter Diversity – Channel known at Transmitter – Channel unknown at Transmitter – The Alamouti Scheme– Transmit & Receive Diversity-MIMO Systems

### **Module-IV:**

**9 hrs**

**Multicarrier Modulation:** Data Transmission using Multiple Carriers – Multicarrier Modulation with Overlapping Sub channels – Mitigation of Subcarrier Fading – Discrete Implementation of Multicarrier Modulation – Peak to average Power Ratio- Frequency and Timing offset – Case study IEEE 802.11a.

### **Module-V:**

**9 hrs**

**CELLULAR CONCEPTS:** Frequency Reuse – Channel Assignment Strategies – Hand off Strategies – Interference and system capacity- Co-Channel Interference- Adjacent Channel

Interference – Trunking and Grade of service – Improving coverage & capacity in cellular systems-Cell Splitting- Sectoring-Repeaters for Range Extension-Microcell Zone Concept.

**Text Book(s):**

1. *David Tse and Pramod Viswanath, "Fundamentals of Wireless Communication", Wiley Series in Telecommunications, Cambridge University Press, 2005.*
2. *Theodore.S. Rappaport, "Wireless Communications: Principles and Practice", 2nd Edition, Pearson Education, India, 2009.*
3. *Andrea Goldsmith, "Wireless Communications", Cambridge University Press, 2005.*
4. *Arogyaswami Paulraj, RokitNabar, Dhananjay Gore, "Introduction to Space-Time Wireless Communication", 1st Edition, Cambridge University Press, 2008.*

**Reference Book(s):**

1. *W.C.Y.Lee, "Mobile Cellular Telecommunications - Analog and Digital Systems", 2nd Edition. Tata McGraw Hill, 2006.*



## CSNS854: AD-HOC MOBILE NETWORKS

L	T	P	C
3	0	0	3

### **Pre-requisite:**

- *Basic Knowledge on wireless networks and understanding of OSI model.*

### **Objectives:**

- *To introduce the characteristic features of Ad-hoc wireless networks and their applications to the students.*
- *To enable the student to understand the functioning of different access and routing protocols that can be.*
- *To enable the student to understand the Mobility in MANETs*

### **Module-I:**

**9 hrs**

**Introduction To MANETS and Mac Layer Protocols:** Fundamentals of Wireless Networks– IP Limitations-Mobile Internet Protocol (IP)- Issues in Mobile IP- Differences between Cellular and Ad Hoc Wireless Networks- Issues in Ad Hoc Wireless Networks- Classification of Ad-hoc Networks-MANET applications- Important Issues and the Need for Medium Access Control (MAC) Protocols.- Classification of MAC Protocols- Multiple-Channel MAC Protocols.

### **Module-II:**

**9 hrs**

**Routing Protocols For Ad Hoc Wireless Networks:** Design Issues of Routing Protocols for Ad Hoc Networks- Classification of Routing Protocols- Proactive Routing- WRP, DSDV, OLSR Protocol - Reactive Routing - AODV, DSR, TORA, CBRP Protocol - Hybrid Routing. - ZRP, ZHLS

### **Module-III:**

**9 hrs**

**Quality Of Service (Qos) In Ad Hoc Networks:** Introduction to QoS -Issues and Challenges Involved in Providing QoS -Classification of QoS Solutions - Medium Access Control (MAC) -Layer QoS Solutions - Network -Layer QoS Solutions -QoS Model -QoS Frameworks - INSIGNIA Protocol Commands - INSIGNIA Protocol Operations - Reservation Establishment -QoS Reporting - Flow Restoration -Flow Adaptation -Intelligent Optimization Self -Regulated adjustment(INORA) - Coarse -Feedback Scheme -Class -Based Fine Feedback

### **Module-IV:**

**9 hrs**

**Energy Management Systems In Ad Hoc Wireless Networks:** Classification of Energy Management Schemes - Overview of Battery Technologies - Principles of Battery Discharge - Impact of Discharge Characteristics on Battery Capacity - Battery Modeling - Battery - Driven System Design - Energy -Efficient Routing Protocol - Transmission Power Management Schemes - Transmission Power Control

**Module-V:****9 hrs**

**Mobility Models For MANET:** Mobility Model Classifications -Formulation of Mobility Models - Mobility Metrics -Impact of Mobility Models on MANET -Random Walk Mobility -Notation, Characteristics of Random Walk Mobility, Stationary Distribution of Random Walk Mobility, Limitations of Random Walk Mobility Model -Random Waypoint Mobility - Notation - Random Waypoint Stochastic Process - Transition Length and Duration - Limitations -Smooth Random Mobility -Notation - Characteristics of Smooth Random Mobility Model - Speed Control – Direction Control - Correlation Between Direction and Speed Change

**Text Book(s):**

1. *Subir Kumar Sarkar, T.G. Basavaraju, C. Puttamadappa, " Ad Hoc Mobile Wireless Networks: Principles, Protocols, and Applications", Second edition, AUERBACH PUBLICATIONS,,2013.*
2. *Radhika Ranjan Roy, "Handbook of Mobile AdHoc Networks for Mobility Models", Springer Science+Business Media, LLC 2011 .*

**Reference Book(s):**

1. *Jonathan Loo, Jaime Lloret Mauri, Jesús Hamilton Ortiz "Mobile Ad Hoc Networks: Current Status and Future Trends" CRC Press, 2012.*
2. *B. V. V. S. PRASAD, "ROUTING ISSUES IN MANETs", Educreation Publishing - 2016*

## CSNS855: ADVANCED MOBILE COMPUTING

L	T	P	C
3	0	0	3

### **Pre-requisite:**

- *Understanding of OSI model and wireless channel transmissions.*

### **Objectives:**

- *To learn mobile computing techniques*
- *To be familiar with mobile computing trends and wireless application protocol.*
- *To learn about the mobile Internet*
- *To study about various application languages and mobile application development platforms*

### **Module-I:**

**9 hrs**

**Mobile Communications: An Overview:** Mobile communication-Mobile computing-Mobile Computing Architecture-Mobile devices-Mobile System Networks – Data dissemination – Mobile management- security. MOBILE DEVICES AND SYSTEMS-Mobile phones – digital Music players – Handheld Pocket computers – Handheld devices – Smart systems – Limitations of mobile devices – Automotive systems.

### **Module-II:**

**9 hrs**

**GSM and Similar Architectures:** GSM – services and architectures – Radio interfaces – Protocols – Localization – Calling – Handover – Security – New data services – General packet radio service- High speed circuit switched data – DECT. WIRELESS MEDIUM ACCESS CONTROL BASED COMMUNICATION-Medium Access Control – Introduction to CDMA –based Systems – Spread spectrum in CDMA Systems – coding methods in CDMA – IS-95 cdmOne System – IMT – 2000 – i-mode – OFDM

### **Module-III:**

**9 hrs**

**Mobile IP Network Layer and Mobile Transport Layer:** IP and mobile Network layers – Packet Delivery and Handover Management – Location management – Registration – Tunneling and Encapsulation - Route Optimization - Dynamic Host Configuration Protocol. Conventional TCP/IP Transport Layer Protocols – Indirect TCP – Snooping TCP – Mobile TCP – Other methods of mobile TCP – layer transmission – TCP over 2.5G/3G Mobile networks

### **Module-IV:**

**9 hrs**

**Mobile Devices: Server and Management:** Mobile agent – Application server – Gateways – Portals -Service Discovery – Device management – Mobile file systems-Security. MOBILE AD HOC AND WIRELESS SENSOR NETWORKS-Introduction to mobile Ad hoc network – MANET –Wireless Sensor Networks –Applications

**Module-V:****9 hrs**

**Wireless LAN, Mobile Internet Connectivity and Personal Area Network:** WirelessLAN (Wi-Fi) Architecture and Protocol layers- WAP 1.1 and WAP 2.0 Architecture – XHTML-MP (Extensible Hypertext Markup Language Mobile Profile) - Bluetooth enabled devices network – layers in Bluetooth protocol- security in Bluetooth protocol- IrDA – ZigBees - Mobile application languages and mobile application development platforms

**Text Book(s):**

1. *Raj Kamal, "Mobile Computing", Oxford Higher education, Second Edition, 2007*
2. *J.Schiller, "Mobile Communication", Addison Wesley, 2000. William Stallings, "Wireless Communication and Networks", Pearson Education, 2003.*
3. *Lothar Merk, Martin.S.Nicklaus and Thomas Stober, "Principle of Mobile Computing", Second Edition, Springer, 2003.*

**Reference Book(s):**

1. *Singhal, "WAP-Wireless Application Protocol", Pearson Education, 2003.*
2. *William C.Y.Lee, "Mobile Communication Design Fundamentals", John Wiley, 1993*

## CSNS856: HIGH SPEED NETWORKS

L	T	P	C
3	0	0	3

### **Pre-requisite:**

- Familiarity with types of computer network, network architecture and network topologies.

### **Objectives:**

- Introduce to ATM and Frame relay.
- Up-to-date survey of developments in High Speed Networks.
- To know techniques involved to support real-time traffic and congestion control.
- Analyse the different levels of quality of service (QoS) to different applications.

### **Module-I: 9 hrs**

**High Speed Networks:** Introduction to Computer Networks –Protocols and the TCP/IP Suite- TCP and IP -Frame Relay - High Speed LAN

### **Module-II: 9 hrs**

**ATM: Introduction:** ATM cell Layered organization Connection admission control ATM cell switching routing and addressing - IP over ATM - Segmentation and reassembly SVC establishment - Circuit emulation Performance management Multicast optical

### **Module-III: 9 hrs**

**Congestion and Traffic Management:** Congestion Control in Data Networks and Internet – Link Level Flow and Error Control – Traffic and Congestion Control in ATM networks

### **Module-IV: 9 hrs**

**Routing:** Overview of graph – interior routing protocol – exterior routing protocol – integrated and differentiated Services – Protocols for Qos Support

### **Module-V: 9 hrs**

**Optical Networks:** Introduction to Optical networks Wavelength division multiplexing (WDM) Introduction to broadcast-and-select networks - Switch architectures - channel accessing Wavelength routed networks Switch architectures - Routing and wavelength assignment virtual topology design IP over SONET over ATM over WDM IP over ATM over WDM IP over WDM.

### **Text Book(s):**

1. William Stallings, *High Speed Networks and Internet*, Pearson Education, Fourth Edition, 2005.
2. Behrouz A. Forouzan, *Data Communications and Networking*, 4th edition, Tata McGraw-Hill, 2005.
3. Warland & Pravin Varaiya, *High Performance Communication Networks*, Jean Harcourt Asia Pvt. Ltd., II Edition, 2001.

### **Reference Book(s):**

1. *Irvan Pepelnjk, Jim Guichard and Jeff Apcar, MPLS and VPN architecture, Cisco Press, Volume 1 and 2, 2003.*
2. *Rajiv Ramaswami and Kumar N. Sivarajan, Optical Networks: A Practical Perspective, 1st Edition, Morgan Kaufmann, USA, 2001.*
3. *C. Siva Ram Murthy and Mohan Gurusamy, WDM Optical Networks: Concepts, Design, and Algorithms, Prentice Hall, USA, 2002.*
4. *Stamatios V. Kartalopoulos, Understanding SONET/SDH and ATM: Communications Networks for Next Millennium, Prentice-Hall of India, 2001.*