Babu Banarasi Das University, Lucknow

Department of Computer Science & Engineering

School of Engineering

Master of Technology (Computer Network) -Regular

Evaluation Scheme

SEMESTER I									
Course Category	**Course Code**	**Code Title**	**Contact Hours**			**Evaluation Scheme**			**Credits**
			L	**T**	**P**	**CIA**	**ESE**	**Course Total**	
C	MCS3101	Advanced Computer Networks	4	0	0	40	60	**100**	**4**
C	MCS3102/ MCS3202	Network and System Security	4	0	0	40	60	**100**	**4**
C	MAS3001	Probability and Statistical Analysis	4	0	0	40	60	**100**	**4**
C	MCS3103	Fundamentals of Theoretical Computer Science	4	0	0	40	60	**100**	**4**
GE		**Generic Elective I**	4	0	0	40	60	**100**	**4**
C	MCS3154	Network and System Security Lab	0	0	2	40	60	**100**	**1**
C	MCS3155	Network Simulation Lab	0	0	2	40	60	**100**	**1**
C	MCS3153	Seminar	0	0	2	100	0	**100**	**1**
Total			**20**	**0**	**6**	**380**	**420**	**800**	**23**

SEMESTER II									
Course Category	Course Code	Code Title	Contact Hours			Evaluation Scheme			Credits
			L	T	P	CIA	ESE	Course Total	
C	MCS3201	TCP/IP Concepts and Programming	4	0	0	40	60	**100**	**4**
C	MCS3203	Mobile Computing	4	0	0	40	60	**100**	**4**
C	MCS3204	Advanced Methods in Distributed Computing	4	0	0	40	60	**100**	**4**
GE		**Generic Elective II**	4	0	0	40	60	**100**	**4**
GE		**Generic Elective III**	4	0	0	40	60	**100**	**4**
C	MCS3254	Mobile Computing Lab	0	0	2	40	60	**100**	**1**
C	MCS3255	Distributed Systems Lab	0	0	2	40	60	**100**	**1**
C	MCS3253	Seminar	0	0	2	100	0	**100**	**1**
Total			**20**	**0**	**6**	**380**	**420**	**800**	**23**

SEMESTER III									
Course Category	Course Code	Code Title	Contact Hours			Evaluation Scheme			Credits
			L	T	P	CIA	ESE	Course Total	
C	MCS3351	State of the art seminar[#]	-	-	-	200	-	**200**	**4**
C	MCS3352	Thesis I[*]	-	-	-	400	-	**400**	**16**
Total			**-**	**-**	**-**	**600**	**-**	**600**	**20**

SEMESTER IV									
Course Category	Course Code	Code Title	Contact Hours			Evaluation Scheme			Credits
			L	T	P	CIA	ESE	Course Total	
C	MCS3451	Thesis II[**]	-	-	-	200	800	**1000**	**28**
Total			**-**	**-**	**-**	**200**	**800**	**1000**	**28**

[#]**SOTA:** The student need to perform a literature survey, will give presentation on state of art topics and will submit a synopsis already mentioned in the problem statement. This will be evaluated internally within two months of the start of the semester and result will be intimated to the students, so to precede for Thesis I.

[*]The student will develop a workable model for the problem they have proposed in the synopsis

[**]This is in continuation with Thesis I. The required experimental/ mathematical verification of the proposed model will be done in this semester.

Legends:

L Number of Lecture Hours per week
T Number of Tutorial Hours per week
P Number of Practical Hours per week
CIA Continuous Internal Assessment
ESE End Semester Examination

Category of Courses:

F Foundation Course
C Core Course
GE Generic Elective
OE Open Elective

Course Code	Generic Elective I
GE34711	IT Security Metrics
GE34712	Introduction to Wireless Networking
GE34713	Cloud Computing
GE34714	Fundamentals of Operating System and DBMS (Compulsory for students of Non-CS background)

Course Code	Generic Elective II
GE34721	Internet Routing Design Principles
GE34722	Digital Forensics for Network, Internet, and Cloud Computing
GE34723	Grid Computing
GE34724	Service-Oriented Computing

Course Code	Generic Elective III
GE34731	Multimedia Networking
GE34732	Wireless Broadband Networks
GE34733	Advance Network Security
GE34734	Wireless Network Security and Privacy

Credit Summary Chart

Course Category	Semester				Total Credits	%age
	I	II	III	IV		
F	0	0	0	0	0	0
C	19	15	20	28	82	87.23
GE	4	8	0	0	12	12.77
Total	**23**	**23**	**20**	**28**	**94**	**100**

Discipline Wise Credit Summary Chart

Course Category	Semester				Total Credits	%age
	I	II	III	IV		
Basic Sciences	0	0	0	0	0	0
Professional Subject Core	18	14	16	28	76	80.85
Professional Subject -General Elective	4	8	0	0	12	12.77
Project Work, Seminar and / or Internship in Industry or elsewhere.	1	1	4	0	6	6.38
Total	**23**	**23**	**20**	**28**	**94**	**100**

SYLLABUS

MCS3101 Advanced Computer Networks

Course Objective:

1. Acquire foundational understanding on the concept of Internetworking in terms of the technologies and techniques that drive Internet;
2. Deepen understanding of advanced concepts of TCP/IP protocol suite and its architecture;
3. Deepen understanding of advanced concepts of OSI protocol suite and its architecture;
4. Earn practical exposure of network model operations in the form of realistic and practical experiments.

Learning Outcome:

At the end of the course, the student should be able to:

1. Identify and explain the essential components that drive internetworking(students would be equipped with the knowledge to explain the relationships between the components and how they affect one another);
2. Understand the important issues encompassing internetworking and how these issues affect the evolution of Internet and its applications;
3. Understand the complete architecture of Internetworking and the operations of underlying protocols and software;
4. Rapidly learn new techniques and to align new technologies to existing Internetworking infrastructure;
5. Equipped with practical knowledge on configuring and monitoring network operations using Internet tools and software.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	**Overview and Network Models** Foundation: Requirements, Connectivity, Cost-Effective Resource Sharing, Support for Common Services ,Network Architecture, Layering and Protocols, OSI Architecture, Internet Architecture, Implementing Network Software, Application Programming Interface (Sockets) , Example Application, Protocol Implementation Issues , Performance, Bandwidth and Latency, Delay × Bandwidth Product, High-Speed Networks, Application Performance Need.	30 Hours	1
II	**Physical Layer, Media and Data link Layer** Direct Link Networks, Physically Connecting Hosts , Hardware Building Blocks, Nodes ,Links ,Encoding (NRZ, NRZI, Manchester, 4B/5B) ,Framing , Byte-Oriented Protocols (PPP), Bit-Oriented Protocols (HDLC) , Clock-Based Framing (SONET), Error Detection, Two-Dimensional Parity, Internet Checksum Algorithm, Cyclic	30 Hours	1

	Redundancy Check, Reliable Transmission, Stop-and-Wait , Sliding Window, Concurrent Logical Channels, Rings (802.5, FDDI, RPR), Token Ring Media Access Control, Token Ring Maintenance, FDDI , Resilient Packet Ring (802.17), Wireless, Bluetooth (802.15.1), Wi-Fi (802.11), WiMax (802.16), Cell Phone Technologies. Packet Switching, Switching and Forwarding, Datagrams, Virtual Circuit Switching, Source Routing, Bridges and LAN Switches, Learning Bridges, Spanning Tree Algorithm , Broadcast and Multicast, Limitations of Bridges, Cell Switching (ATM) ,Cells, Segmentation and Reassembly , Virtual Paths, Physical Layers for ATM, Implementation and Performance Ports , Fabrics		
III	**Network Layer and Transport Layer** Internetworking, Simple Internetworking (IP), What Is an Internetwork?, Service Model, Global Addresses, Datagram Forwarding in IP, Address Translation (ARP), Host Configuration (DHCP), Error Reporting (ICMP) Virtual Networks and Tunnels, Routing, Network as a Graph, Distance Vector (RIP), Link State (OSPF) ,Metric, Routing for Mobile Hosts, Router Implementation, Global Internet . End-to-End Protocol, Simple Demultiplexer (UDP), Reliable Byte Stream (TCP), End to- End Issues, Segment Format, Connection Establishment and Termination, Sliding Window Revisited, Triggering Transmission, Adaptive Retransmission Record Boundaries, TCP Extensions , Alternative Design Choices ,Remote Procedure Call, RPC Fundamentals, RPC Implementations (SUNRPC, DCE), Transport for Real-Time Applications (RTP), Requirements, RTP Details, Control Protocol, Performance, Open Issue: Application-Specific Protocols. Data Compression, Lossless Compression Algorithms Image Compression (JPEG), Video Compression (MPEG), Transmitting MPEG over a Network.	30 Hours	1
IV	**Application Layer and Security** Network Security, Cryptographic Tools, Principles of Ciphers, Symmetric-Key Ciphers , Public-Key Ciphers, Authenticators , Key Predistribution, Predistribution of Public Keys, Predistribution of Symmetric Keys, Authentication Protocols, Originality and Timeliness Techniques, Public-Key Authentication Protocols, Symmetric-Key Authentication Protocols, Diffie-Hellman Key Agreement, Secure Systems, Pretty Good Privacy (PGP), Secure Shell	30 Hours	1

	(SSH), Transport Layer Security (TLS, SSL, HTTPS), IP Security (IPSec), Wireless Security (802.11i), Firewalls, Strengths and Weaknesses of Firewalls, Open Issue: Denial-of-Service Attacks, Applications: Traditional Applications, Electronic Mail (SMTP, MIME, IMAP), World Wide Web (HTTP), Name Service (DNS), Network Management (SNMP).		

Text/Reference Books:

1. A. Tanenbaum, "Computer Network", Prentice Hall, 2002.
2. J.F. Kurose and K.W. Ross, "Computer Networking, A Top-Down Approach Featuring the Internet", Addison-Wesley, 2002.
3. D.E. Comer, "Computer Networks and Internets with Internet Applications", Prentice-Hall, 2001.
4. L.L. Peterson and B.S. Davie, "Computer Networks, A Systems Approach", Morgan Kaufmann, 2000.

MCS3102/ MCS3202 Network and System Security

Course Objective:

1. Have a fundamental understanding of the objectives of cryptography and network security
2. Become familiar with the cryptographic techniques that provide information and network security
3. To know the different types of algorithms of exchanging information in a secret way.
4. To know the possible threats which can breach the secure communication

Learning Outcome:

1. Understand cryptography and network security concepts and applications
2. Apply security principals to system design
3. Identify and investigate network security threats
4. Analysis of network traffic and security threats

Course Contents:

Module	Course Topics	Total Hours	Credits
I	**Introduction to Cryptography and Symmetric Ciphers** Security Attacks: Security Services and mechanism; Classical encryption techniques: Substitution ciphers and Transposition ciphers, Steganography, Cryptanalysis; Modern Block Ciphers: Stream and Block Cipher, Block Cipher Principles, Block Cipher Modes of Operations; Shannon's theory of Confusion and Diffusion; Fiestal structure; Data encryption standard(DES); Strength of DES; Idea of differential cryptanalysis; Triple DES; Symmetric Key	30 Hours	1

	Distribution; Finite Fields: Introduction to groups, rings and fields, Modular Arithmetic, Euclidean Algorithm, Finite Fields of the form GF(p).		
II	**Basics of Number Theory and Public key Cryptography** Introduction to Number Theory: Prime and Relative Prime Numbers, Fermat's and Euler's theorem, Testing for Primality, Chinese Remainder theorem, Discrete Logarithms; Public Key Cryptography: Principles of Public-Key Cryptography, RSA Algorithm, Security of RSA; Key Management: Deffie-Hellman Key Exchange, ElGamal Public key cryptosystems.	30 Hours	1
III	**Hash Functions and Digital Signatures** Message Authentication; Hash Functions; Secure Hash Functions; Security of Hash functions and MACs; Digital Signatures; Digital Signature Standards (DSS); Proof of digital signature algorithm; Advanced Encryption Standard (AES) encryption and decryption	30 Hours	1
IV	**Network and System Security** Authentication Applications: Kerberos, X.509 Certificates; Electronic Mail Security: Pretty Good Privacy, S/MIME; IP Security: IP Security Architecture, Authentication Header, Encapsulating security payloads, Combining Security Associations; Web Security: Secure Socket Layer and Transport Layer Security, Secure Electronic transaction; Intruder; Viruses; Firewalls.	30 Hours	1

Text/Reference Books:

1. William Stallings, "Cryptography and Network Security: Principals and Practice", Pearson Education.
2. Behrouz A. Frouzan, "Cryptography and Network Security", Tata McGraw-Hill.
3. Bruce Schiener, "Applied Cryptography". John Wiley & Sons
4. Bernard Menezes," Network Security and Cryptography", Cengage Learning.
5. Atul Kahate, "Cryptography and Network Security", Tata McGraw-Hill

MCS3103 Fundamentals of Theoretical Computer Science

Course Objective:

1. Automata are mathematical machines, that is, abstract computing devices. Their purpose is to capture study and compare different models and views of the abstract notion of computation and its various aspects.

2. The computational power of automata can be characterized through the classes of languages (that is, sets of strings over a finite alphabet of symbols) they can accept/recognize.
3. Important notions in computer science like state, non-determinism and minimization are captured in the simple model of finite automata, which recognize the class of regular languages.
4. Automata provide the basis for the implementation of many programming languages, with parsing being a typical example for the application of pushdown automata, which recognize the more powerful class of context-free languages.
5. Another important reason for studying automata is to capture the notion of effective computability, that is, to characterize the notion of computation as a process which can be physically implemented. This allows the important question to be posed: what problems can be decided algorithmically, and where are the limits to this? The most influential model for studying these issues is Turing machines.

Learning Outcome:

1. The overall aim of the course is to provide students with a profound understanding of computation and effective computability through the abstract notion of automata and the language classes they recognize.
2. Along with this, the students will get acquainted with the important notions of state, non-determinism and minimization.
3. After the course, the successful student will be able to perform the following constructions:
   - 3.1 Determining and minimizing automata.
   - 3.2 Construct an automaton for a given regular expression.
   - 3.3 Construct a pushdown automaton for a given context-free language.
   - 3.4 Construct a Turing machine deciding a given problem.
   - 3.5 Prove undecidability of a given problem by reducing from a known undecidable problem

Course Contents:

Module	Course Topics	Total Hours	Credits
I	Mathematical Preliminaries: Sets, Relations, Partial Orders, Well-ordered sets, Structural induction, Cardinality of Sets. Logic : Basics of propositional and first order logic, completeness and compactness results	30 Hours	1
II	Models of computation: Classification, Properties and equivalences, Regular languages models, Finite state machines (deterministic and nondeterministic). Grammars - Production systems - Chomsky hierarchy, Regular grammars, Regular expressions, Equivalence of deterministic and non-deterministic machines. Properties: closure decidability, minimality of automata, iteration theorems.	30 Hours	1
III	Recursive and recursively enumerable sets models: Turing machines, grammars, recursive functions, their	30 Hours	1

	equivalence. Context-free languages models: grammars (including different normal forms). Pushdown automata and their equivalence. Properties: closure, iteration theorems, parsing.		
IV	Church's thesis, undecidability, Post machines, and Computational complexity: time & tape bounds, time & tape bounded simulations, notion of complexity classes, classes P & NP, NP-completeness, some natural NPcomplete problems.	30 Hours	1

Text/Reference Books:

1. Raynold M. Smullyan, "First-Order Logic", Springer-Verlag, 1968.
2. J. E. Hopcroftand J. Ullman, "Introduction to Antomata Theory, Languages of Computations". Addison Wesley.
3. W. Thomas, "Languages, automata, and logic", in G. Rozenberg and A. Salomaa, editors, Handbook of Formal Languages, Springer, New York, 1997.

Generic Elective- I

GE34711 IT Security Metrics

Course Objective:

1. IT security metrics provide a practical approach to measuring information security.
2. Evaluating security at the system level.
3. IT security metrics are tools that facilitate decision making and accountability through collection, analysis.
4. It security metrics tools facilitates reporting of relevant performance data.

Learning Outcome:

1. Define the metrics program goals and objectives
2. Decide which metrics to generate
3. Develop strategies for generating the metrics
4. Establish benchmarks and targets
5. Determine how the metrics will be reported
6. Create an action plan and act on it
7. Establish a formal program review/refinement cycle

Course Contents:

Module	Course Topics	Total Hours	Credits
I	**Introduction** What Is a Security Metric? Metric and Measurement, Security Metrics Today; Designing Effective Security Metrics: Choosing Good Metrics; GQM for Better Security Metrics; More Security Uses for GQM; Understanding Data: What Are Data?, Data Sources for Security Metrics.	30 Hours	1
II	**Security Process Management**	30	1

	The Security Process Management Framework; Managing Security as a Business Process; Analyzing Security Metrics Data: Steps, Analysis Tools and Techniques	Hours	
III	**Measurements of Security** Measurements Security Operations :Sample Metrics for Security Operations, Sample Measurement Project for Security Operations ;Measuring Compliance and Conformance :The Challenges of Measuring Compliance, Sample Measurement Projects for Compliance and Conformance; Measuring Security Cost and Value, The Importance of Data to Measuring Cost and Value; Measuring People, Organizations, and Culture: Sample Measurement Projects for People, Organizations, and Culture.	30 Hours	1
IV	**Security Improvement Program** Moving from Projects to Programs; Managing Security Measurement with a Security; Requirements for a SIP, Measuring the SIP; Learning Security: Different Contexts for Security Process Management, Organizational Learning, Three Learning Styles for IT Security Metrics.	30 Hours	1

Text/Reference Books:

1. "IT Security Metrics", Lance Hayden, TATA McGraw-HILL.
2. "Security Metrics", CAROLINE WONG, TATA McGraw-HILL

GE34712 Introduction to Wireless Networking

Course Objective:

1. Study the basic concepts and functions of Wireless Local Area Networks.
2. Study the basic concepts of IEEE 802.11.
3. Study the basic concepts of Bluetooth.
4. Study the basic concepts of Mobile and Ad Hoc Network.
5. Study the basic concepts of wireless sensor network.

Learning Outcome:

At the end of the course, the student should be able to:

1. An ability to understand the basics of Wireless Local Area Networks.
2. To analyze the concept of Bluetooth.
3. To analyze and understand the Mobile and Ad Hoc Network.
4. To analyze the basic concepts of IEEE 802.11.
5. An ability to understand the basic concepts of wireless sensor network.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	**Basics of Wireless Communications.** Basics of Wireless Communications: Harmonic	30 Hours	1

	Signals and Exponentials, Electromagnetic Waves and Multiplexing, Modulation and Bandwidth, Basics of Wireless Local Area Networks, Networks Large and Small, WLANs from LANs. 802.11 WLANs, Hyper LAN, From LANs to PANs, Wireless Link Overview, Systems, Power, Noise, Link Budgets. Radio Transmitters and Receivers; Overview of Radios, Radio Component; Radio System Design; Examples of Radio Chips and Chipsets; Radio Propagation; Mechanisms of Radio Wave Propagation; Open Field Propagation; Diffraction; Scattering; WiMax; VoWi-Fi and Bluetooth; VoWi-Fi and DECT; VoWi-Fi, OtherOngoing 802.x Wireless Projects.		
II	**MOBILE Ad Hoc Network and Wireless network.** Mobile Ad Hoc Networks; Physical Layer and MAC ;Routing in Ad Hoc Networks; Wireless Sensor Networks; Applications; Plant Network Layouts; Plant Network Architecture; Sensor Subnet Selection; Functional Requirements; Reliable Wireless Networks for Industrial Applications; Benefits of Using Wireless; Issues in Deploying Wireless Systems; Wireless Formats; Wireless Mesh Networks; Industrial Applications of Wireless Mesh Networks; Applications and Technologies; Wireless Local Area Networks (WLAN); Bluetooth; Zigbee; Conflict and Compatibility; Ultra-wideband Technology.	30 Hours	1
III	**High-Speed Wireless Data & Overview of the IEEE.** High-Speed Wireless Data: System Types, Standards-Based and Proprietary Solutions, Fixed Networks, Nomadic Networks, Mobile Networks; Standards-Based Solutions and Proprietary Solutions. Overview of the IEEE 802.11 Standard; Overview of the IEEE 802.16 Standard; 10–66 GHz Technical Standards; 8 2–11 GHz Standards; Overview of the IEEE 802.20 Standard Terrain Based Models; Effectively Using a Propagation Analysis Program Using a Predictive Model; The Comprehensive Site Survey Process; Survey Activity Outline, Identification of Requirements; Identification of Equipment Requirements; The Physical Site Survey; Determination of Antenna Locations; RF Site Survey Tools The Site Survey Checklist; The RF Survey; Data Analysis.	30 Hours	1
IV	**Security in Wireless Local Area Networks.** Indoor Networks: Behind Closed Doors, Microwave Properties of Building Materials, Realistic Metal	30 Hours	1

	Obstacles, Real Indoor Propagation, Indoor Interferers, Tools for Indoor Networks; Security in Wireless Local Area Networks; Key Establishment in 802.11; Anonymity in 802.11; Authentication in 802.11; Confidentiality in 802.11; Data Integrity in 802.11; Loopholes in 802.11 Security; 10.8 WPA; 10.9 WPA2; (802.11i) Voice Over Wi-Fi and Other Wi-Fi and Cellular Networks.		

Text/ Reference Books:

1. Anurag Kumar, D. Manjunath, and Joy Kuri, "Wireless Networking".
2. Timothy J. "Bluetooth Application Programming with the Java APIs".
3. Thompson, Paul J. Kline, and C. Bala Kumar, "Internet Multimedia Communications Using SIP", Rogelio Martinez Perea
4. Yi Qian, JamesJoshi, David Tipper, and Prashant, "Information Assurance: Dependability and Securityin Networked Systems".

GE34713 Cloud Computing

Course Objective:

1. To impart fundamental concepts in the area of cloud computing.
2. To impart knowledge in applications of cloud computing.
3. This course covers a series of current cloud computing technologies, including technologies for IaaS, PaaS and SaaS models.
4. To impart knowledge of the different layers of the cloud technologies, practical solutions such as Google, Amazon, Microsoft, SalesForce.com, etc.

Learning Outcome:

At the end of the course, the student should be able to:

1. Understanding the systems, protocols and mechanisms to support cloud computing.
2. Develop applications for cloud computing
3. Understanding the hardware necessary for cloud computing.
4. Design and implement a novel cloud computing application.
5. Accessing the services of the cloud computing.
6. Understand the concept of the virtualization.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	**Cloud Computing Basics:** Introduction**:** Cloud Computing Overview**,** CloudComponents, Services Infrastructure**,** Applications, Storage**,** Cloud Application Architectures**,** The Value of Cloud Computing**,** Cloud Infrastructure Models**,** Database Services**,** Intranets and the Cloud components**,** Hypervisor Applications, First Movers in the Cloud: Amazon, Google, Microsoft	30 Hours	1
II	**Organization and Cloud Computing:** When You	30	1

	Can Use Cloud Computing, Benefits, Scalability, Simplicity, Knowledgeable More Internal Resources Security Limitations, Developing Your Own Applications, Platforms, Web Application Framework, Web Hosting Service, Proprietary Methods, Web Applications, Sample Applications Web APIs	Hours	
III	**Developing Applications and Accessing of cloud:** Google PaymentForce.com and Google Google Gears, Microsoft Live Services, Microsoft SQL, Microsoft .NET Services, Microsoft SharePoint Services and Dynamics CRM Services, Design Intuit QuickBase, Cast Iron Cloud, Bungee Connect Development, Google App Engine, Salesforce.com, Microsoft Windows Azure Troubleshooting, Application Management	30 Hours	1
IV	**Virtualization:** Local Clouds and Thin Clients Virtualization in an Organization, How to Virtualize Security Concerns, Server Solutions, Microsoft Hyper-V, VMware Infrastructure	30 Hours	1

Text/Reference Books:

1. Anthony T Velte and Toby J Velte, "A Cloud computing: Practical Approach", Mc-GrawHill.
2. Syed A Ahson, "Cloud computing and Software Services", CRC Press.
3. George Reese, "Cloud Application Architectures", O'Reilly Press.

GE34714 Fundamentals of Operating System and DBMS

Course Objective:

1. Study the basic concepts and functions of operating systems.
2. Study the basic concepts of Database management system.
3. Understand the structure and functions of OS.
4. Learn about Processes, Threads and Scheduling algorithms.
5. Understand the principles of concurrency and Deadlocks.
6. Learn various memory management schemes.
7. Study I/O management and File systems.

Learning Outcome:

At the end of the course, the student should be able to:

1. Design various Scheduling algorithms.
2. Apply the principles of concurrency.
3. Design deadlock, prevention and avoidance algorithms.
4. Compare and contrast various memory management schemes.
5. Design and Implement a prototype file systems

Course Contents:

Module	Course Topics	Total Hours	Credits

I	**INTRODUCTION TO OPERATING SYSTEM** Introduction to operating systems; Process management: Process synchronization, Mutual exclusion, Two process solution, Dekker's algorithm, semaphores, examples (producer-consumer, readers-writer, dining philosophers, etc.);CPU scheduling: Multiprogramming, Time sharing, Scheduling approaches (SJF,FIFO, round robin, etc.); Input/Output: Device controllers, Device drivers, Disks, other devices. Memory management: With and without swapping, Virtual memory; Paging and segmentation: Page replacement algorithms, implementation; File systems: FS services, Disk space management, directory and data structure; Deadlocks: modeling, Detection and recovery, prevention and avoidance.	30 Hours	1
II	**Introduction to Database System** The entity-relationship model: Beyond the ER Model, Entities, Attributes, and Entity Sets, Relationships and Relationship Sets, Additional Features of the ER Model; Key Constraints: Participation Constraints, Weak Entities; Class Hierarchies Aggregation; Conceptual Database Design With the ER Model: Entity versus Attribute, Entity versus Relationship, Binary versus Ternary Relationships, Aggregation versus Ternary Relationships; Conceptual Design for Large Enterprises. Introduction to the Relational Model; Integrity Constraints over Relations: Key Constraints, Foreign Key Constraints, General Constraints, Enforcing, Integrity Constraints, Querying Relational Data; Logical Database Design; ER to Relational, Introduction to Views, Destroying/Altering Tables and Views.	30 Hours	1
III	**Relational algebra and calculus.** Relational Algebra: Selection, Projection, Set Operations, Renaming, Joins, Division, Relational Calculus, Tuple Relational Calculus ,Domain Relational Calculus, Expressive Power of Algebra and Calculus; Structure query language: Queries, Programming, Triggers. The Form of a Basic SQL Query: Expressions and Strings in the SELECT Command, UNION, INTERSECT.,EXCEPT, Nested Queries, Aggregate Operators, Null Values, Embedded SQL, Cursors, ODBC, JDBC; Complex Integrity Constraints in SQL: Triggers and Active Databases, Constraints versus Triggers; The Memory Hierarchy; RAID; Data Striping; Redundancy; Disk	30 Hours	1

	Space Management; Files and Indexes: File organizations and indexes: Cost Model; Heap Files, Sorted Files, Hashed Files, Choosing a File Organization, Indexes, Properties of Indexes; Tree-structured indexing: Indexed Sequential Access Method (ISAM), B+ Trees, Format of a Node, Search Insert, Delete; Hash-based indexing: Static Hashing, Extendible Hashing, Linear Hashing, Extendible Hashing versus Linear Hashing; Evaluation of relational operators: Introduction to Query Processing, The Selection Operation, General Selection Conditions, The Projection Operation, The Join Operation, The Set Operations, Aggregate Operations; Introduction to query optimization: Overview of Relational Query Optimization, System Catalogue in a Relational DBMS, A typical relational query optimizer, Translating SQL Queries into Algebra, Estimating the Cost of a Plan, Relational Algebra Equivalences, Enumeration of Alternative Plans, Nested Sub queries, Other Approaches to Query Optimization.		
IV	Schema refinement and normal forms: Functional Dependencies, Normal Forms, Decompositions, Normalization, Other Kinds of Dependencies; introduction to Database Security: Access Control, Discretionary Access Control, Mandatory Access Control; Transaction management overview: The Concept of a Transaction, Transactions and Schedules, Concurrent Execution of Transactions, Lock-Based Concurrency Control; Introduction to Crash Recovery: Lock-Based Concurrency Control Revisited, Lock Management, Specialized Locking Techniques, Transaction Support in SQL, Concurrency Control without Locking; Crash recovery: Recovering from a System Crash, Media Recovery, Other Algorithms and Interaction with Concurrency Control.	30 Hours	1

Text/Reference Books:

1. J. Peterson, A. Silberschatz, and P. Galvin, “Operating System Concepts”, Addison Wesley.
2. A. V. Aho, R. Sethi, and J. D. Ullman, “Compilers: Principles, Techniques and Tools”, Addison-Wesley.
3. R. El. Masri and S. B. Navathe, “Fundamentals of Data Base Systems”, Benjamin Cummings.
4. Abraham Silberschatz, Henry F. Korth, S. Sudarshan, “Database System Concepts”.

MCS3154 Network and System Security Lab

Tools/Software used: C/C++/Java

1. Write program for Mono alphabetic cipher.
2. Implementation of Play Fair cipher.
3. Implementation of Vigenere cipher (Polyalphabetic substitution).
4. Implementation of Hill cipher.
5. Implementation of Gauss cipher.
6. Implementation of Rail Fence cipher.
7. Implementation of S-DES algorithm for data encryption.
8. Implement RSA asymmetric (public key and private key)-Encryption. Encryption key (e, n) & (d,n)
9. Generate digital signature using Hash code.
10. Generate digital signature using MAC code.

MCS3155 Network Simulation Lab

NS2: Installation, Running NS2 Simulation, Including C++ modules into NS2 and make utility Linkage between Otcl and C++ in NS2, Class Tcl, Class InstVar, Class TclObject, TclClass, TclCommand. Implementation of discrete event simulation in NS2, Network Objects: Creation, Configuration and packet Forwarding, Nodes as Routeror Computer Hosts, link and Buffer Management, Packets, packet Headers, and Header Format, Transport Control Protocol: TCP Receiver, TCP Sender, TCP Transmission Functions.

Text/Reference Books:

1. Teerawat Issariyakul, EkramHossain, “Introduction to Network Simulator NS2”, Springer.

MCS3201 TCP/IP Concepts and Programming

Course Objective:

1. To learn the basics of socket programming using TCP Sockets.
2. To develop knowledge of threads for developing high performance scalable applications.
3. To understand simple network management protocols & practical issues
4. To learn basics of UDP sockets.

Learning Outcome:

1. Realize network communication skills through programming.
2. Understand and apply the principles and practices of socket programming.
3. Acquire a good knowledge of the TCP/IP, its architecture and operation.
4. Follow trends of internetworking

Course Contents:

Module	Course Topics	Total Hours	Credits
I	**Client-Server Interaction Model (Socket Interface, BOOTP, DHCP)**	30 Hours	1

	Introduction, The Client-Server Model, Complexity of Server, RARP Servers, The Unix I/O Paradigm and Network I/O, Sending and Receiving data through a Socket, IP address manipulation routines, Obtaining Information about Host, BOOTP and DHCP:BOOTP Operations, BOOTP Message format, DHCP Operations, DHCP Message format		
II	**Domain Name System** Name Space: Hierarchical Name Space, Domain Name Space: Label, Domain Name, and FQDN. Distribution Of Name Space: Hierarchy of Name Servers, Zone, Root Server .DNS in the Internet , Resolution: Mapping Names to address, Mapping Address to Names, Recursive Resolution, Iterative Resolution, Caching . Types of Record: Resource record. Zone Delegation, Zone transfer, DDNS	30 Hours	1
III	**Telnet, Rlogin and Voice over IP(RTP)** Concept of Telnet**,** Telnet Protocol and options, Timesharing Environment , Network Virtual Terminals, Mode of operations, Rlogin, Real Time Transport Protocol(RTP) :RTP encapsulation , RTP control protocol, RTCP operations, RSVP, QoS	30 Hours	1
IV	**World Wide Web, Electronic Mail and File Transfer** File Transfer Protocol (FTP): FTP features, FTP Process Model. TFTP, NFS: NFS Implementation. RPC, Simple Mail Transfer Protocol: User Agent, Addresses, Mail Transfer Agent, Mail Transfer phases. MIME: MIME Multipart Messages. POP, Hyper Text Transfer Protocol: Architectural Components, URL, HTTP Transactions, HTTP Message Format(Header, Response message)	30 Hours	1

Text/Reference Books:

1. Douglas E.Comer, “Internetworking with TCP/IP, Principles, Protocols and Architectures”, PHI.
2. Forouzan BA, “TCP/IP Protocol Suite”, TMH.
3. “TCP/IP Unleashed”, Pearson Education.

MCS3203 Mobile Computing

Course Objective:

1. To provide guidelines, design principles and experience in developing applications for small, mobile devices, including an appreciation of context and location aware services
2. To develop an appreciation of interaction modalities with small, mobile devices (including interface design for non-standard display surfaces) through the implementation of simple applications and use cases.

3. To introduce wireless communication and networking principles, that support connectivity to cellular networks, wireless internet and sensor devices.
4. To understand the use of transaction and e-commerce principles over such devices to support mobile business concepts
5. To appreciate the social and ethical issues of mobile computing, including privacy.

Learning Outcome:

At the end of the course, the student should be able to:

1. A working understanding of the characteristics and limitations of mobile hardware devices including their user-interface modalities
2. The ability to develop applications that are mobile-device specific and demonstrate current practice in mobile computing contexts.
3. A comprehension and appreciation of the design and development of context-aware solutions for mobile devices.
4. An awareness of professional and ethical issues, in particular those relating to security and privacy of user data and user behavior.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	Evolution from 2G over 3G to 4G: Beyond 3G Network Architectures, Overview: UMTS, HSPA (HSDPA and HSUPA) Introduction to Network Architecture, Air Interface and Radio Network, LTE-Introduction, Network Architecture, Air Interface and Radio Network, Basic Procedures, Summary and Comparison with HSPA	30 Hours	1
II	802.16 WiMAX: Introduction, Network Architecture, The 802.16d Air Interface and Radio Network, The 802.16e Air Interface and Radio Network, Basic Procedures, Summary and Comparison with HSPA and LTE, 802.16m: Complying with IMT Advanced, 802.16j: Mobile Multi-hop Relay , 802.11Wi-Fi: Introduction, Network Architecture The Air Interface –from 802.11b to 802.11n Air Interface and Resource Management, Basic Procedures, Wi-Fi Security, Quality of Service: 802.11e	30 Hours	1
III	Network Capacity and Usage Scenarios: Usage in Developed Markets and Emerging Economies, How to Control Mobile Usage, Per Minute Charging, Volume Charging, Split Charging, Small-screen Flat Rates, Strategies to Inform Users When Their Subscribed Data, Measuring Mobile Usage from a Financial Point of View, Cell Capacity in Downlink, Current and Future Frequency Bands for Cellular Wireless, Cell Capacity in Uplink, Per-user Throughput in Downlink, Per-user Throughput in the	30 Hours	1

	Uplink Traffic Estimation Per user, Overall Wireless Network Capacity, Network Capacity for Train Routes, Highways and Remote Areas, A Hybrid Cellular/Wi-Fi Network for the Future		
IV	Voice over Wireless, Circuit-switched Mobile Voice Telephony: Circuit Switching, A Voice-optimized Radio Network, The Pros of Circuit Switching, Packet-switched Voice Telephony, Network and Applications are Separate in Packet-Switched Networks, Wireless Network Architecture for Transporting IP packets, Benefits of Migrating Voice Telephony to IP, Voice Telephony Evolution and Service Integration, Voice Telephony over IP: the End of the Operator Monopoly, SIP Telephony over IP network.	30 Hours	1

Text/Reference Books:

1. J. Schiller, "Mobile Communications", Addison Wesley.
2. A. Mehrotra , "GSM System Engineering".
3. M. V. D. Heijden, M. Taylor, "Understanding WAP", Artech House.
4. Charles Perkins, "Mobile IP", Addison Wesley.
5. Charles Perkins, "Adhoc Networks", Addison Wesley.

MCS3204 Advanced Methods in Distributed Computing

Course Objective:

1. Have knowledge and understanding of the main principles, techniques and methods involved when dealing with distributed systems.
2. Have detailed knowledge and understanding of major issues related to the design of a distributed system, such as: - how to communicate between distributed objects by means of remote invocation
3. Have detailed knowledge and understanding of the absence of global physical time in distributed systems.
4. Have detailed knowledge and understanding of how processes can coordinate their actions in distributed transactions.
5. Have the ability to design and implement prototypical distributed computing applications using different technologies.

Learning Outcome:

At the end of the course, the student should be able to:

1. Understand the contrasting features between the distributed views of computing with the centralized one.
2. Understand in detail how distributed applications work and what requirements they aim to satisfy.
3. Understand in detail how distributed applications work and what issues and challenges they must contend with.
4. Understand in detail how distributed applications work and what architecture they exhibit.

5. Understand in detail how distributed applications work and what techniques and infrastructures they are built upon.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	Introduction to distributed systems: A model of distributed computations, A distributed program, A model of distributed executions, Models of communication networks, Global state of a distributed system, Cuts of a distributed computation, Past and future cones of an event, Models of process communications. Logical Time: A framework for a system of logical clocks: Scalar time, Vector time, Matrix time, Virtual time, Physical clock synchronization. Global State: Local State and state of channel, System Model And Definitions, Snapshot recording Algorithms : Snapshot recording algorithm for FIFO Channels, Variations of the Chandy–Lamport algorithm, Snapshot algorithms for non-FIFO channels, Snapshots in a causal delivery system, Monitoring global state, Necessary and sufficient conditions for consistent global snapshots, Finding consistent global snapshots in a distributed computation.	30 Hours	1
II	Message ordering: Message ordering paradigms, Asynchronous execution with synchronous communication, Synchronous program order on an asynchronous system; Group communication : Causal order (CO) , Total order , A nomenclature for multicast, Propagation trees for multicast, Classification of application-level multicast algorithms, Distributed multicast algorithms at the network layer. Termination Detection: System model of a distributed computation, Termination detection using distributed snapshots, Termination detection by weight throwing, A spanning-tree-based termination detection algorithm, Message optimal termination detection, Termination detection in a very general distributed computing model, Termination detection in the atomic computation model, Termination detection in a faulty distributed system	30 Hours	1
III	Mutual Exclusion: Non- Token based mutual exclusion algorithms: Lamport's algorithm, Ricart–Agrawala algorithm, Quorum-based mutual exclusion	30 Hours	1

	algorithms: Maekawa's algorithm, Agarwal–El Abbadi quorum-based Algorithm, Token-based Algorithms: Suzuki–Kasami's broadcast algorithm, Raymond's tree-based algorithm. Deadlock detection in distributed systems :Models of deadlocks, Knapp's classification of distributed deadlock detection algorithms, Mitchell and Merritt's algorithm for the single resource model, Chandy–Misra–Haas algorithm for the AND model Chandy–Misra–Haas algorithm for the OR model.		
IV	Distributed shared memory: Memory consistency models, Shared memory mutual exclusion, Wait-freedom Register hierarchy and wait-free simulations, Wait-free atomic snapshots of shared objects classification of predicate. Check pointing and rollback recovery :Definitions, Issues in failure recovery, Checkpoint-based recovery, Log-based rollback recovery, Koo–Toueg coordinated check pointing algorithm, Juang–Venkatesan algorithm for asynchronous check pointing and recovery, Manivannan–Singhal quasi-synchronous check pointing algorithm.	30 Hours	1

Text/Reference Books:

1. Singhl & Shivaratri, "Advanced Concept in Operating System", McGraw Hill.
2. Coulouris, Dollimore, Kindberg, "Distributed System: Concepts and Design" Pearson Education Press.
3. Gerald Tel, "Distributed Algorithms", Cambridge University Press

Generic Elective – II

GE34721 Internet Routing Design Principles

Course Objective:

1. This course deals with general concepts and design alternatives for inter-domain routing, i.e., routing between autonomous systems in the Internet.
2. Students will get a deep understanding of the design, configuration, and operation of inter-domain routing in general.
3. In particular, students will get hands-on experience in using the Border Gateway Protocol (BGP).

Learning Outcome:

At the end of the course, the student should be able to:

1. Identify design principles of an scalable converged networks
2. Describe at a conceptual level, the principles underlying scalable routing protocols e.g. multi area OSPF, EIGRP, BGP

3. Identify and effectively communicate the advantages and limitations of scalable routing protocols and their suitability for the small, medium and large enterprise
4. Configure the routers of a designed internet with the appropriate scalable routing protocols for internal connectivity and access to an Internet Service Provider (ISP)
5. Explain internal and external Border Gateway Protocol (BGP) properties and limits, and configure routers for a typical enterprise to ISP connection scenario
6. Optimize an internet's use of routing updates in a multi-protocol scenario
7. Compare and contrast interior and exterior scalable routing protocols.
8. Configure routers using a mixture of IPv4 and IPv6 protocols
9. Appreciate emerging routing techniques and trends

Course Contents:

Module	Course Topics	Total Hours	Credits
I	**Introduction** Networking and Network Routing: An Introduction; Addressing and Internet Service: An Overview, Network Routing, IP Addressing, Service Architecture; Protocol Stack Architecture; Router Architecture; Network Topology; Architecture; Network Management Architecture; Public Switched Telephone Network	30 Hours	1
II	**Routing Algorithms** Shortest Path and Widest Path: Bellman–Ford Algorithm, Distance Vector Approach, Dijkstra's Algorithm, Widest Path Algorithm, Dijkstra-Based Approach, Bellman–Ford-Based Approach, k-Shortest Paths Algorithm; OSPF and Integrated IS-IS: OSPF, Protocol Features: OSPF Packet Format, Integrated IS-IS: Key Features, comparison; BGP: Features, Operations, Configuration Initialization, phases, Message Format; IP Routing; Distance Vector Protocol Family: RIPv1, RIPv2.	30 Hours	1
III	**Routing Protocols** Framework and Principles, Routing Protocol, Routing Algorithm, Routing Table, Routing Information Representation, Protocol Messages, Distance Vector Routing Protocol, Link State Routing Protocol, Path Vector Routing Protocol, Link Cost	30 Hours	1
IV	**Internet Routing and Router Architectures** Architectural View of the Internet; Allocation of IP Prefixes and AS Number; Policy-Based Routing; Point of Presence; Traffic Engineering Implications; Internet Routing Instability; Router Architectures: Functions, Types, Elements of a Router, Packet Flow; Packet Processing: Fast Path versus Slow Path; Routing and Traffic Engineering: Traffic Engineering of IP/MPLS Networks, VPN Traffic Engineering, Problem	30 Hours	1

	Illustration: Layer 3 VPN; LSP Path Determination: Constrained Shortest Path Approach, LSP Path Determination, Network Flow; Modeling Approach; Layer 2 VPN Traffic Engineering; Observations and General Modeling Framework; Routing/Traffic Engineering for Voice Over MPLS.		

Text/Reference Books:

1. Deepankar Medhi and Karthikeyan Ramasamy, "Network Routing: Algorithms, Protocols, and Architectures" (Morgan Kaufmann Series in Networking).
2. George Varghese, "Network Algorithmic: An Interdisciplinary Approach to Designing Fast Networked Devices" (Morgan Kaufmann Series in Networking).

GE34722 Digital Forensics for Network, Internet and Cloud Computing

Course Objective:

1. Study the basic concepts of Computer Forensics and Investigations.
2. Elaborate on, compare and evaluate theories of digital forensics.
3. Support digital forensics specialists by collecting, preserving, storing and analysing digital forensic evidence
4. Learn about the importance of DHCP Logs and Snort.
5. Understand the principles of Commercial Net Flow Applications and Silent Runner.
6. Study Internet Forensics and Cloud Forensics.
7. Study the Future of Cloud Computing.

Learning Outcome:

At the end of the course, the student should be able to:

1. Define and discuss the concepts of computer forensics.
2. Explain the career of a computer forensics professional.
3. Explain and apply the concepts of computer investigations.
4. Setup and operate in an investigator's office and laboratory.
5. Select and apply current computer forensics tools.
6. Identify and apply current practices for processing crime and incident scenes.
7. Explain and apply digital evidence controls.
8. Explain and perform forensic analysis in various operating system environments.
9. Explain the boot processes and disk structures of various operating system environments.
10. Identify and apply current practices for data discovery recovery and acquisition.
11. Conduct basic computer forensic analysis.
12. Demonstrate the recovery of image files.
13. Conduct basic network forensic analysis.
14. Perform e-mail investigations.
15. Act as expert witness and report results of investigations

Course Contents:

Module	Course Topics	Total Hours	Credits
I	**Unit 1:**Understanding Computer Forensics, Computer Forensics and Investigations, Data Acquisition, Working with windows and DOS Systems, Computer Forensics Tools, Forensics Analysis and Validation, Network Forensics, Introduction to Cloud Computing, Introduction to the Incident Response Process, Investigative and Forensics Methodologies, Where Network Forensics Fits In?, Capturing Network Traffic, The Importance of DHCP Logs, Using TCPDump/ WinDump, Using Wireshark, Using SPAN Ports or TAPS, Using Fiddler, Firewalls, Placement of Sensors, Using Snort for Network-Based Forensics, IDS Overview, Snort Architecture, Snort Preprocessor Component ,Snort Detection Engine Components, Network Forensics Evidence Generated with Snort.	30 Hours	1
II	**UNIT2:** Other Network Evidence, Overview of Botnets and Other Network-Aware Malware, Temporal, Relational, and Functional Analyses and Victimology, First Responder Evidence, Dynamic Evidence Capture, Malware Analysis: Using Sandbox Technology, Deciphering a TCP Header, OSI and TCP Reference Models, TCP Header ,Decipherment of a TCP Segment, TCP Signature Analysis, Incorporating Network Forensics into Incident Response Plans, Investigation Method ,Incident Response, DMCAViolations, Web Site Compromise: Search Engine Spam and Phishing	30 Hours	1
III	**UNIT3:** Commercial Net Flow Applications**,** What Is Net Flow? What Is an FNF? What Is an sFlow? Which Is Better: NetFlow or sFlow? Scrutinizer, Using Flow Analytics to Identify Threats within NetFlow. NetWitnessInvestigator, NetWitness Investigator Architecture, Import/Live Capture Network Traffic, Collections, Parsers, Feeds, and Rules, Navigation Views, Data Analysis, Exporting Captured Data, Silent Runner by Access Data ,History of Silent Runner, Installing Silent Runner, Silent Runner Terminology.	30 Hours	1
IV	**UNIT4:** Legal Implications and Considerations, Internet Forensics, Cloud Forensics, International Complexities of Internet and Cloud Forensics, Putting It All Together, Network Forensics Examiner Skills, Network Forensics Investigation Life Cycle, The Future of Cloud Computing, History of Cloud Computing ,Current State of Cloud Computing ,Next Phases of Cloud Computing, The Future of Network	30 Hours	1

	Forensics, Today's Challenges with Existing Devices for Network Forensics, Network Forensics Quadrants of Focus Network Forensics Analysis Tools.		

Text/Reference Books:

1. Clint Garrison, "Digital Forensics for Network, Internet and Cloud Computing", Syengress.
2. Bill Nelson, Amelia Phillips, Christopher Steuart, "Guide to Computer Forensics and Investigations".

GE34723 Grid Computing

Course Objective:

1. To provide an overview of the basic concepts of Grid Computing
2. To highlight the advantages of deploying Grid Computing
3. To illustrate the practical adoption of a Grid deployment through real life case studies.
4. To impart the knowledge of the Globus tool kit.

Learning Outcome:

At the end of the course, the student should be able to:

1. Understand and explain the basic concepts of Grid Computing
2. Explain the advantages of using Grid Computing within a given environment
3. Prepare for any upcoming Grid deployments and be able to get started with a potentially available Grid setup.
4. Learn the implementations and developing the applications using Globus tool kit.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	**Concepts and Architecture:** Introduction: Parallel and Distributed Computing**,** Cluster Computing**,** Grid Computing**,** Anatomy and Physiology of Grid**,** Worldwide Initiatives Grid Computing Organizations**,** Roles of the Grid Computing**,** The Grid Computing Road Map**,** OGSA**:** Some Sample Use Cases that Drive the OGSA**,** The OGSA Platform Components**,** Open Grid Services Infrastructure,WSRF	30 Hours	1
II	**Grid Monitoring:** Grid Monitoring Architecture (GMA)**,** An Overview of Grid Monitoring Systems**:** GridICE**,** JAMM**,** MDS**,** Network Weather Service**,** Other Monitoring Systems**,** GangliaGridMon	30 Hours	1
III	**Gid Security and Resource Management:** Grid Security**,** Security Primer**,** PKI-X509 Certificates**,** Working principles of Scheduling, A Review of Condor, SGE, PBS and LSF**,** Grid Scheduling with QoS, Grid Scheduling**,** Scheduling Paradigms**,** Resource Management	30 Hours	1

IV	**Data Management and Grid Tool kit:** Data Management**:** Categories and Origins of Structured Data**,** Data Management Challenges**,** Architectural Approaches**,** Collective Data Management Services**,** Federation Services**,** Grid Portals**,** First Generation Grid Portals**,** Second Generation Grid Portals**,** GLOBUS GT3 Toolkit**:** Architecture GLOBUS GT3 Toolkit**,** Implementation GLOBUS GT3 Toolkit	30 Hours	1

Text/Reference Books:

1. Joshy Joseph & Craig Fellenstein, "Grid Computing", Pearson/PHI PTR.
2. Ahmar Abbas, "Grid Computing: A Practical Guide to technology and Applications", Charles River media.
3. "Grid Computing for Developers", Valdimir Silva, Charles River Media, USA**.**

GE34724 Service Oriented Computing

Course Objective:

1. Present the emergence of Service-Oriented Computing as a new computing paradigm.
2. Service-Oriented Architecture (SOA) is a way to organize and use distributed capabilities that may be controlled by different owners.
3. The course aims to formulate the foundational concepts of services, to evaluate existing approaches, and to present existing techniques from other areas that can be adopted for services.
4. The course includes Introduction of techniques for information and process semantics, specifically, conceptual modeling, ontologies, matchmaking, messaging, transactions, and processes.
5. The course aims to give the student an understanding of the strengths and weaknesses of a service-based architecture.

Learning Outcome:

At the end of the course, the student should be able to:

1. Design and launch Web services.
2. Learn approaches to compose services.
3. Use, in their own programs, Web services published by others.
4. Perform matchmaking on Web services.
5. Evaluate emerging and proposed standards for the main components of Web services architectures.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	Basic Principles**:** Integration Concepts**,** A2A, B2B, and B2C**,** Integration types**,** Information portals Shared data**,** Shared business functions**,** Differences between EAI and SOA**,** Semantic integration and the role of data**,** Enterprise Application**,** Integration	30 Hours	1

	(EAI),Levels of integration, Messaging, Message brokers and Messaging infrastructure, Publish/subscribe, Enterprise Service Bus, The core functions of an ESB, The structure of an ESB. Middleware: Middleware communication methods, Middleware base technologies, Routing scheme. Integration architecture variants: Point-to-point architecture, Hub-and-spoke architecture, Pipeline architecture, Service-oriented architecture. Patterns for service-oriented integration. Process integration. Event-driven architecture. Introducing EDA. Event processing. Grid computing/Extreme Transaction Processing (XTP).Data grids. Distribution topologies. Agents, Execution patterns.		
II	Solid State Disks and grids Base Technologies. Transactions: Transactional systems Isolation levels, Serializable, Repeatable read, Read committed, Read uncommitted, Phantom reads, Two-Phase Commit protocol (2PC), XA transactions. OSGi architecture: OSGi bundles Collaborative model. Java Connector Architecture (JCA):Java Business Integration (JBI).Service Component Architecture (SCA). Service Data Objects (SDO): SDO architecture Implemented patterns. Process modeling: Event-driven Process Chain (EPC), Business Process Modeling Notation (BPMN), Business Process Execution Language (BPEL).	30 Hours	1
III	Integration Architecture Blueprint: standards, components and patterns used Structuring the integration blueprint, The road to the integration blueprint, Applications and integration, Layers in the integration solution, Information flow and roles, Information flow and building blocks, Combining the collection and distribution layer, Change of direction in the information flow, Adding the process layer, The role of the process layer. Vendor Products for Implementing the Trivadis Blueprint: Oracle Fusion Middleware product line, Oracle Application Integration Architecture (AIA), Oracle Data Integrator, IBM Web Sphere product line, IBM Information Management software.	30 Hours	1
IV	Implementation scenarios: EAI/EII scenarios: Implementing the direct connection business pattern, Service-oriented integration scenarios, Implementing the process, Integration business pattern, Variant with externalized business rules in a rule engine, Variant with batch-driven integration process, Implementing the workflow business pattern. Data integration scenarios: Implementing the federation business pattern EDA scenario, Implementing the event	30 Hours	1

	processing business pattern. Grid computing/XTP scenario**:** Implementing the grid computing business pattern**,** Connecting to an SAP system**,** Modernizing an integration solution**,** Trivadis Architecture Blueprints and integration		

Text/ Reference Books:

1. Giudo Schmutz, "Service Oriented Architecture: An Integration Blueprint", Packt Publishing, Mumbai.
2. Thomas Eri, "Service Oriented Architecture: Concepts, Technology, and Design", Prentice Hall.
3. Dimitrios Georgakopoulous, "Service Oriented Computing", MIT Press**.**

Generic Elective –III

GE34731 Multimedia Networking

Course Objective:

1. The course allows students to support or design networks which run effectively multimedia applications.
2. Developers for multimedia applications will understand the influences of the network and means to adapt to them by existing methods.
3. Students will understand the market drivers and the directions for further development

Learning Outcome:

At the end of the course, the student should be able to learn in the following areas:

1. **Applications**
   Students will learn to use and configure essential office applications including word processing, spreadsheets.
2. **Image and video processing**
   Students will learn various image and video coding algorithms
3. **Internet Technologies**
   Students will develop a basic understanding of technologies and protocols used on the Internet, and how to effectively use Internet tools technologies including current web-based applications, e-mail, and social networking tools; developing searching strategies; and basic web authoring.

Course Contents:

Module	**Course Topics**	**Total Hours**	**Credits**
I	Introduction to Multimedia Networking, Paradigm shift of Digital Media Delivery, Telematics: Infotainment in automobiles, Major components of Multimedia Networking. Digital Speech Coding, Digital Speech Coding: LPC modeling and Vocoder, Regular Pulse Excitation with long-term prediction, Code-Excited Linear Prediction (CELP), Multiple-	30 Hours	1

	Pulse-Excitation Coding Digital Audio Coding: Human Psychoacoustics, Subband Signal Processing and Polyphase Filter implementation, MPEG-1 Audio Layers, Dolby AC3 Audio Codec,MPEG-2 Advanced Audio Coding (AAC), MPEG-4 AAC (HE-AAC).		
II	Digital Image Coding: Basics of Information Theory for Image Compression, Entropy Coding, Lossy Image Compression, Joint Photographic Experts Group (JPEG), JPEG2000. Digital Video Coding, Evolution of Digital Video Coding, Compression Techniques for Digital Video Coding, H.263 and H.263þ Video Coding, MPEG-1 and MPEG-2 Video Coding, MPEG-4 Video Coding and H.264/AVC, H.264/MPEG-4 AVC, Scalable extension of H.264/AVC by HHI.	30 Hours	1
III	Digital Multimedia Broadcasting, Moving from DVB-T to DVB-H, T-DMB Multimedia broadcasting for portable devices. Multimedia Quality Of Service of IP networks, Layered Internet Protocol (IP), IP Quality Of Service, QoS mechanisms, IP Multicast and Application-Level Multicast (ALM), Layered Multicast of Scalable Media. Quality Of Service issues in Streaming Architectures, QoS mechanisms for Multimedia Streaming, Windows Media streaming technology by Microsoft, Sure Stream Streaming Technology by Real Networks, Internet Protocol TV (IPTV).	30 Hours	1
IV	Wireless Broadband and Quality Of Service, Evolution of 3G Technologies, Wi-Fi Wireless LAN (802.11), QoS enhancement support of 802.11, Worldwide Interoperability for Microwave Access (WiMAX), Internetworking between 802.16 and 802.11. Multimedia over Wireless Broadband, End-To-End Transport error control, Error resilience and power control at the source coding layer, Multimedia over Wireless mesh, Wireless VoIP and scalable video. Digital rights management of multimedia, A generic DRM architecture, Encryption, Digital watermarking, MPEG-21. Implementations of multimedia networking, Speech and audio compression module, Image and video compression module, IP networking module, Audio and video capturing and displaying, Encoding and decoding of video or audio, Building a client–server video streaming system, Creating a small P2P video conferencing system.	30 Hours	1

Text/ReferenceBooks:

1. Jenq-neng Hwang, "Multimedia Networking: From Theory To Practice", Cambridge University Press.
2. Syed Mahbubur Rahman, "Multimedia networking: technology, management and applications", IGI Global.

GE34732 Wireless Broadband Networks

Course Objective:

1. Understanding the concepts of mobile cellular networks such as WiFi,3G, 4G, and also the new coming 5G.
2. To be able to understand the network standard, radio wave propagation.
3. Focus on Private wireless networks and their characteristics and current practices.
4. Follow broadband networks trends.
5. To fulfill experiences with company visit and group discussion.

Learning Outcome:

1. Enabling technologies including OFDMA, MIMO and ultra wideband communications.
2. System and architecture of Long-Term Evolution (LTE) cellular networks, WiMAX, wireless LAN (WLAN) and cognitive radio Networks.
3. Techniques / methodologies applicable to the problems of network design, performance evaluation and network planning for wireless broadband networks.
4. Apply the knowledge of the principles underlying modern data networks.
5. Independent learning ability required for continuing professional study.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	Orthogonal Frequency-division multiplexing and other clock based transmissions; Wireless communication systems, Block-based Transmissions, Orthogonal Frequency-division Multiplexing Systems, Single-carrier Cyclic Prefix Systems, Orthogonal Frequency-division Multiple Access, Single-carrier Frequency-division, Multiple Access, CP-based Code Division Multiple Access, Receiver Design. Multiple-input, Multiple-output Antenna systems: Introduction, MIMO System Model, channel Capacity, Diversity, Diversity and Spatial Multiplexing Gain, SIMO Systems, MISO Systems, Space-Time Coding, MIMO Transceiver Design, SVD-based Eigen-Beam forming, MIMO for Frequency-Selective Fading Channels, Transmitting Diversity for Frequency-Selective Fading Channels, Cyclic Delay Diversity. Ultra wideband: Introduction, Time-Hopping Ultra wideband, Direct-Sequence Ultra	30 Hours	1

	Wideband, Multiband, Other Types of UWB.		
II	Medium Access Control: Introduction, Slotted ALOHA MAC, CSMA-CA MAC, Polling MAC, Reservation MAC, Energy-Efficient MAC, Multichannel MAC, Directional- Antenna MAC, Multihop Saturated Throughput of IEEE 802.11 MAC, Multiple Access Control. Mobility Resource Management: Types of Handoffs, Handoff Strategies, Channel Assignment Schemes, Multiclass Channel Assignment Schemes, Location Managements, Mobile IP, Cellular IP, HAWAII.	30 Hours	1
III	Routing Protocols for Multihop Wireless Broadband Networks: Multihop Wireless Broadband Networks: Mesh Networks, Importance of Routing Protocols, Routing Metrics, Classification of Routing Protocols, MANET Routing Protocols. Radio Resource Management for Wireless Broadband Networks: Packet Scheduling, Admission Control, Ad Hoc Wireless Sensor Networks (WSNs), Communication Coverage, Sensing Coverage, Localization Routing, Function Computation, Scheduling, S-MAC, IEEE 802.15.4 (Zigbee).	30 Hours	1
IV	Wireless Local Area Network: Network Architectures, Physical Layer of IEEE802.11n. Medium Access Control, Mobility Resource Management, Quality of Services, Applications. Wireless Personal Area Network: Network Architectures, Physical Layer of IEEE802.11n. Medium Access Control, Mobility Resource Management, Routing Quality of Services, Applications. Convergence of Networks: 3GPP/WLAN Interworking, IEEE 802.11u, Interworking with External Networks, LAN/WLAN/WiMax/3G Interworking based on IEEE 802.22 Media Independent Handoff, Future Cellular/WiMax/WLAN/WPAN Interworking, Analytical Model for Cellular/WLAN Interworking	30 Hours	1

Text/Reference Books:

1. David Tung Chong Wong, Peng-yong Kong, Ying-chang Liang, "Wireless Broadband Networks", John Wiley & Sons**.**

GE34733 Advanced Network Security

Course Objective:

1. Examine the principles of firewall design and implementation.
2. Describe standard firewall functionality and common implementation practices Real-time scheduling and schedulability analysis
3. Define the function of IPSec in a networked environment.
4. Examine IPSec policy management.

5. Apply firewall concepts and knowledge by designing a firewall topology and rule sets to create the required firewall security posture for a specific network situation.

Learning Outcome:

At the end of the course, the student should be able to:

1. Explain computer networking security and voice concepts to both technical peers and non-technical management.
2. Describe the fundamentals of wireless local area networks, including their operations, IEEE 802.11 framing options, configuration essentials, and vulnerabilities.
3. Examine the process of intrusion detection and how behavioral use is implemented in the IDS.
4. Compare and contrast host-based and network-based IDSs.
5. View and analyze network traffic fragmentation.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	**Computer Network Security** Basic background , Current Issues, Internet Security: Secure Routing, Networking Technologies, Attacks in Networks, State of the Art Designing Firewalls, Firewall Classification, Firewall Deployment: Management, Security in Virtual Private Networks: VPN Technology, VPN Taxonomy IP Security (IPSecs): IPSecs Architecture and Components , Benefits and Applications of IPSec, IDs for Networks: Background, Modern NIDSs, Intrusion Detection versus Intrusion Protection: IPS Deployment and Advantages, IPS Requirements Denial of Service Attacks, DoS and DDoS Attacks and Defence mechanism, Secure Architectures with Active Networks	30 Hours	1
II	**Security in E-Services and Applications** What is an E-Service? , Security Requirements for E-Services and Applications, Security for future E-Services, Security in Web Services: Web Services Technologies and Standards, Web Services Security Standard, Secure Multicasting: IP Multicast, Application Security Requirements, Source Authentication Schemes, Group Key Management, Secure Multicast Architectures, Secure IP Multicast Standardization Efforts.	30 Hours	1
III	**Voice Over IP Security** Security Issues in VoIP, Vulnerability Testing, Intrusion Detection Systems, Grid Security: Security Challenges for Grids, Grid Security Infrastructure, Grid Computing Environments, Grid Network	30 Hours	1

	Security, Mobile Agent Security: Taxonomy of Solutions, Security Mechanism for Mobile Agent Systems		
IV	**Mobile terminal Security** IEEE 802.11 Security, Introduction of IEEE 8002.11, Wired Equivalent Privacy, Wireless Intrusion Detection Systems Bluetooth Security: Bluetooth wireless Technology, Security Architecture, Security Weaknesses and Countermeasures Security in Mobile Ad Hoc networks : Routing Protocols, Security vulnerabilities, Preventing Attacks in MANETs, Trust in MANETs, Establishing Secure Routes in a MANETs, Cryptographic tools for MANETs, Wireless Sensor Networks: Sensor Devices, Sensor Network Security	30 Hours	1

Text/Reference Books:

1. Christos Douligeris, Dimitrios N. Serpanos, "Network security: current status and future directions", Wiley Inderscience.
2. Chris McNab, "Network Security Assessment", O'Reilly Media.
3. Ankit Fadia, "Network Security 2e Paperback".

GE34734 Wireless Network Security and Privacy

Course Objective:

1. Study the basic concepts and functions of Wireless Networks.
2. Study the basic concepts of Security Primitives and Wireless Networks.
3. Study the basic concepts of Fundamental of Cellular system.
4. Study the basic concepts of Security Issues in Single & Multi hop Wireless Network..
5. Study the basic concepts of Security Issues in Wireless Systems.

Learning Outcome:

At the end of the course, the student should be able to:

1. Understand the basics of Wireless Networks.
2. To analyze the concept of cellular system.
3. To analyze and understand the Security Primitives and Wireless Networks.
4. To analyze the basic concepts of Security Issues in Wireless Systems.
5. Understand the basic concepts of Security Issues in Single & Multi hop Wireless Network..

Course Contents:

Module	Course Topics	Total Hours	Credits
I	**Introduction to Wireless Networks** Evolution of Wireless Networks: Challenges, Overview of various Wireless Networks; Wireless Communications Principles; Fundamentals Cellular	30 Hours	1

	Systems: 1G, 2G,3G, 4G. Satellite Networks; Fixed Wireless Access Systems; W-LAN; HIPER-LAN Wireless ATM and its Architecture; PersonalArea Networks;		
II	**Introduction to Security Primitives and Wireless Networks** Introduction to Cryptography; Symmetric Key Cryptography; Public Key Cryptography; Hash Function Authentication Protocol; Miscellaneous Techniques; Hash Chain; Secret Sharing.	30 Hours	1
III	**Security Issues in Single & Multi hop Wireless Network.** Cellular Network and WLAN Security: Access Control, Roaming Issues, Mobile IP Security, RFID Security, Pervasive Computing Security; Security Issues in Multihop Wireless Networks; Mobile Ad hoc Network Security: Trust Management and Routing Issues, Wireless Sensor; Network Security: Key Management and False Data Filtering, Vehicular Network Security.	30 Hours	1
IV	**Security Issues in Wireless Systems.** The Need for Wireless Network Security; Attacks on Wireless Networks; Security Services; Wired Equivalent Privacy (WEP) Protocol; Mobile IP; Weaknesses in the WEP Scheme; Virtual Private Network (VPN);Wi-Fi protected access (WPA) and WPA 2.	30 Hours	1

Text/Reference Books:

1. Levente Buttyan and Jean-Pierre Hubaux, “Security and Cooperation in Wireless Networks”, Cambridge University Press.
2. T. S. Rappaport, “Wireless Communications Principles and Practices”, Pearson Education.
3. William Stallings, “Wireless Communications and Networks”, Pearson Education.
4. Yi-BaNG Lin and Imrich Chlamtac, “Wireless and Mobile Network Architectures”, Wiley.
5. Garg, “Wireless Network Evolving: 2G to 3G”, Pearson Education.
6. Y. C. Lee, “Mobile Communication System”.
7. John R. Vacca, “Guide to Wireless Network Security”, Springer.
8. Steve Mann, Scott Sbihli, “The Wireless Application Protocol”, Wiley.
9. Jochen Schiller, “Mobile Communications”, Pearson.
10. A. K. Talukder, R.R. Yavagal, “Mobile Computing- Technology, Applications and Service Creation”, TMH.

MCS3254 Mobile Computing Lab

1. To implement Code Division Multiple Access (CDMA).
2. To study frequency reuse concept.
3. To study basic concept og J2ME.

4. To study various classes (such as TextBox, ChoiceGroup , Drop Down menus etc.) and their implementation in J2ME.
5. To design a simple WML page using various WML tags.
6. To implement mobile network using NS2.
7. Study Assignments 1: Detailed study of Bluetooth
8. Study Assignment 2: Detailed study of Wireless Application Protocol .
9. Set up and configuration of aceess point
10. Study Assignment 3: To study network security software's.

MCS3255 Distributed System Lab

(Working Knowledge of Linux/UNIX Operating system and Java programming is required.)

1. Logical Clocks: Implement a Logical Clock, Jard–Jourdan's adaptive technique
2. Learn to compile and deploy a grid service using Globus Toolkit.
3. Shortcut deployment of grid service using ant.
4. Implement Vector Clocks.
5. Simulate Balanced Sliding Window Protocol.
6. Implement Distributed mutual exclusion algorithms: Singhal's dynamic information-structure algorithm, Lodha and Kshemkalyani's fair mutual xclusion algorithm, Agarwal–El Abbadi quorum-based algorithm, Raymond's tree-based algorithm.
7. Implement Deadlock detection in distributed systems: Mitchell andMerritt's algorithm for the single resource model, Chandy–Misra–Haas algorithm for the AND model, Chandy–Misra–Haas algorithm for the OR model.
8. Testing and debugging distributed programs using global predicates.