Vellore Institute of Technology
(Deemed to be University under section 3 of UGC Act, 1956)

SCHOOL OF ELECTRONICS ENGINEERING

M. Tech Electronics and Communication Engineering (Intelligent Communication Systems)

(M.Tech - ICS)

Curriculum and Syllabus

(*2025 - 2026 admitted students*)

VIT®
Vellore Institute of Technology
(Deemed to be University under section 3 of UGC Act, 1956)

Adaptive Curriculum for Excellence –ACE

M. Tech Electronics and Communication Engineering

(Intelligent Communication systems)

Program Educational Objectives

1. An industrial path for engineers to build a strong professional profile by mastering core fundamentals and applying advanced technology concepts in real-world scenarios.
2. An academic research path dedicated to explore the cutting-edge innovations in next-generation intelligent networks, preparing individuals for impactful contributions in research and academia.
3. An Entrepreneurial path for building a business or startup in the communication and networking sector, focusing on innovation in 5G solutions, RF technology applications, or advanced communication infrastructure.

Program Outcomes

PO1: An ability to independently carry out research /investigation and development work to solve practical problems

PO2: An ability to write and present a substantial technical report/document

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program.

PO4: Acquire advanced knowledge of RF, baseband, and network systems with the ability to analyze and synthesize evolving global applications.

PO5: Utilize advanced software tools and state-of-the-art engineering hardware to develop solutions for complex problems in communication engineering.

PO6: Acquire ethical research practices and professional integrity to support sustainable community and societal growth.

Curriculum Structure

Program Credit Structure	**Credits**
University Core Courses	39
Professional Core Courses	24
Professional Elective courses	14
Open Elective Courses	03
Total Graded Credit Requirement	**80**

University Core courses (39 Credits)

S.No	Course Title	L	T	P	C
1	Technical Report Writing	1	0	4	3
2	Qualitative and Quantitative Skills Practice I	3	0	0	3
3	Qualitative and Quantitative Skills Practice II	3	0	0	3
4	Project Work	0	0	0	10
5	Internship I/ Dissertation I	0	0	0	10
6	Internship II/ Dissertation II	0	0	0	10
	Total Credits				39

Syllabus for Programme Core and Elective Courses

Program Core Courses (24 Credits)						
S. No	Course code	Name of the Course	L	T	P	C
1	MAEIC502	Communication Networks	3	1	0	4
2	MAEIC506	Wireless Communication Technologies	3	0	2	4
3	MAEIC501	Machine Learning for Communications	3	0	2	4
4	MAEIC504	Multimedia Communication Systems	3	1	0	4
5	MAEIC505	Embedded C Programming	3	0	2	4
6	MAEIC503	Internet of Things	3	0	2	4
		Total Credits				24

Program Elective (14 Credits)						
S. No	Course code	Name of the Course	L	T	P	C
7	MAEIC601	5G New-Radio	3	0	0	3
8	MAEIC602	Signal Processing Algorithms	3	0	0	3
9	MAEIC603	Network Security	3	0	2	4
10	MAEIC604	System-on-Chip using Verilog HDL	3	0	2	4
11	MAEIC605	Wireless Sensor Networks	3	0	0	3
12	MAEIC606	Smart Antenna	3	0	2	4
13	MAEIC607	Optical Networks	3	0	0	3
14	MAEIC608	Quantum Communication	3	0	2	4
15	MAEIC609	Edge AI for Intelligent Computing	3	0	0	3
16	MAEIC610	Soft Computing	3	0	0	3
17	MAEIC611	Blockchain Technology	3	0	0	3

Course Code	Course Title	L	T	P	C
MAEIC502	**Communication Networks**	**3**	**1**	**0**	**4**
Pre-requisite		**Syllabus Version**			
		1.0			

Course Objectives

1. Introduce students to the principles and functionalities of network services and layered architectures, emphasizing the role of each layer in data communication.
2. Build comprehensive knowledge of link-level protocols, flow and error control mechanisms, medium access control strategies, routing algorithms, and congestion control techniques.
3. Enable students to gain insight into the performance metrics of high-speed networks and the evolving features of intelligent networks in modern communication systems.

Course Outcomes

1. Employ Networking principles and OSI/TCP-IP models in data communication systems.
2. Implement error detection, correction, and randomized medium access protocols to ensure reliable data transfer.
3. Analyze the performance metrics of Internet and routing protocols.
4. Employ congestion control mechanisms and the behavior of TCP and UDP in communication networks.
5. Apply high-speed networking concepts in modern communication systems.

Module:1	Network Services and Layered Architectures	10 hours

Network architectures, layered protocols, Network service interface, Networking principles, Applications, Traffic characterization, Network elements, Basic network Mechanisms, Concept of layered architecture modeling including OSI and the TCP/IP protocol suite, Network bottlenecks.

Module:2	Data Link Layer Protocols	14 hours

Link layer functionalities, frame synchronization, error detection and control - ARQ, Efficiency of ARQ - flow control mechanisms including sliding windows, High Level Data Link Control (HDLC). Randomized medium access: Unslotted and Slotted Aloha, System throughput analysis and two-user saturation rate region analysis. CSMA, System throughput analysis and two-user rate region analysis for p-persistent CSMA, CSMA/CD (IEEE 802.3), CSMA/CA (IEEE 802.11)-System throughput analysis.

Scheduling approaches to MAC- Delay performance - Scheduling for TDMA/FDMA/CDMA based wireless networks.

Module:3	Routing and Network Layer	14 hours

Network layer protocols, including IPV4, IPV6, ARP and ICMP. IP addressing schemes (Classful and Classless), Subnetting and Subnet Masking, SNMP, Routing protocols - Distance Vector and Link State Routing- link metric estimation and neighborhood table management for proactive and reactive routing protocols- Software Defined Networking.

Module:4	Congestion control	10 hours

Transport layer protocols - Transmission Control Protocol and User Datagram Protocol – Effects of congestion - congestion control mechanisms, Behavior of TCP, Challenges and solutions for TCP over wireless networks, UDP behavior over WLAN, Effect of access based on RTS/CTS, Behavior of TCP over WLAN, Influence of errors in UDP and TCP.		
Module:5	**High Speed and Intelligent Networks**	**10 hours**
Packet switching networks, High speed LAN, Ethernet, WLAN (IEEE 802.11), VLAN, VPN, and Enterprise Network. Intelligent Wireless Networks- Case Studies- Design Challenges and Open Issues		
Module:6	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**60 hours**

Text Books

1.	Leon Gracia, Widjaja, Communication Networks, 2019, 6th Edition, McGraw Hill, New York, USA.
2.	William Stallings, High-speed Networks and Internets, 2012, 2nd Edition, Pearson Education, United Kingdom.

Reference Books

1.	W. Stallings, Data and Computer Communications, 2017, 10th Edition, Pearson Prentice Hall, USA.
2.	Jerry FitzGerald, Alan Dennis, Alexandra Durcikova, Business Data Communications and Networking, 2021, 14th Edition, ISBN: 978-1-119-70284-9 ,Wiley.

Mode of Evaluation: Quiz, Assignment, Project, CAT and FAT

Recommended by Board of Studies			
Approved by Academic Council	**No.**	**Date**	

Pre-requisite	Nil	Syllabus Version
		1.0

Course Objectives

1. Comprehend the propagation of wireless signals through various environments.
2. Build the fundamental concepts and operational techniques of CDMA, OFDM, and NOMA.
3. Explore the principles and performance of various MIMO techniques.

Course Outcomes

1. Compare the key features, underlying principles, services and technical challenges of different generations of wireless communication technologies
2. Determine the performance of various multiple access techniques in wireless communication systems.
3. Apply the principles of MIMO and wireless technologies to enhance the capacity and reliability of wireless systems.
4. Compare the architecture, features, and applications of various wireless systems standards, including cellular, WLAN and 5G.
5. Apply fundamental principles of cellular architectures, signal propagation, advanced techniques (MIMO, OFDM, diversity), and evolving wireless standards in implementation of wireless communication systems.

Module:1	Evolution of Wireless Communications	5 hours

Introduction to wireless communications, Evolution of wireless communication systems-2G/3G/4G/5G, Types of Services, Requirements for the Services, Technical Challenges of Wireless Communications, Noise- and Interference-Limited Systems.

Module:2	Wireless Propagation Channels	9 hours

Propagation Mechanism, Large scale propagation - Free space propagation model, Two-ray ground reflection model, Path loss model, Outdoor propagation model, Okumura model, Hata model, Link power budget analysis, Small-scale propagation - Parameters of mobile multipath channels, Types of small-scale fading, Rayleigh and Rician distributions, Jakes Doppler spectrum.

Module:3	Multiple Access techniques	9 hours

Code Division Multiple Access (CDMA), Orthogonal Frequency Division Multiplexing (OFDM) principle - Implementation of transceivers, Cyclic prefix, Peak-to-Average Power Ratio (PAPR), Inter Carrier Interference, BER analysis of OFDM. Non-Orthogonal Multiple Access (NOMA)-Power domain, Code domain, Interference alignment. Orthogonal time frequency spreading (OTFS)-Signal representation, Implementation as overlay, Diversity and Channel gain. Orthogonal Time Frequency Division Multiplexing (OTFDM) principle- Channel Modeling-Signal representation.

Module:4	MIMO and Wireless technologies	12 hours

MIMO system model, MIMO Configurations-SISO, SIMO, MISO, and MIMO, Diversity Techniques-Diversity Gain, Selection Combining (SC), Maximal Ratio Combining (MRC), Equal Gain Combining (EGC), MIMO receivers-Zero Forcing (ZF), Minimum Mean Square Error (MMSE). Advanced MIMO techniques-Beamforming techniques, Spatial multiplexing, Multi-user MIMO Massive MIMO-Channel model, Channel hardening, Matched filter receiver, Pilot contamination, Radio wave propagation for Millimeter wave technology, Large-scale and Small-scale propagation channel effects, Applications of mm-Wave communications, Spatial Modulation, Reflecting Intelligent Surface (RIS).		
Module:5	**Wireless Systems and Standards**	**8 hours**
Cellular standards-GSM, IS-95, CDMA 2000, WCDMA/UMTS, LTE, Wi-Fi/IEEE 802.11, Wi-MAX/IEEE 802.16, LPWAN, 5G NR		
Module:6	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Books	
1	Andreas F. Molisch, Wireless Communications: From Fundamentals to Beyond 5G, 2022, 3rd Edition, John Wiley & Sons, United States.
2	Aditya K. Jagannatham, Principles of Modern Wireless Communications Systems, 2017, 1st Edition, McGraw Hill Education, India.
Reference Books	
1.	Theodore S. Rappaport, Wireless Communications: Principles and Practice, 2023, 2nd Edition (Updated), Pearson Education, India.
2.	Matthew S. Gast, 802.11 Wireless Networks: The Definitive Guide; Enabling Mobility With Wi-fi Networks, 2018, 3rd Edition, O'Reilly Media
Mode of Evaluation: Quiz, Assignment, Design Project, Case Study, Seminar, CAT and FAT	

List of Experiments (Indicative)	
Simulate and analyze the relationship between increasing traffic and call blocking probability in GSM networks using a network simulator	**2 hours**
Utilize a network simulator to demonstrate and contrast how mobility is managed and handovers are executed in GSM, CDMA, and LTE.	**2 hours**
Investigate how the throughput in an LTE network is affected by varying the eNB's channel bandwidth and the separation distance between the eNB and the User Equipment.	**4 hours**
A comparative analysis of the received signal strength as determined by various radio propagation models: Friis, two-ray, considering log-normal shadowing, Okumura, and Hata.	**4 hours**

Design and simulate a scenario using a network simulator to investigate the fundamental principles and potential benefits of LTE direct Device-to-Device (D2D) communication in an underlay network.	**2 hours**
To simulate and compare the Bit Error Rate (BER) performance of Selection Combining (SC), Maximal Ratio Combining (MRC), and Equal Gain Combining (EGC) in a Rayleigh fading channel.	**4 hours**
To compare the throughput performance of WLANs using different MIMO configurations (e.g., SISO, 2x2 MIMO, 4x4 MIMO) under similar channel conditions.	**2 hours**
Simulate and compare the BER performance of ZF and MMSE MIMO detection techniques across multiple antenna configurations.	**4 hours**
Examination of the PAPR characteristics, the impact of frequency offset leading to ICI, and the BER performance of OFDM signals when transmitted through various channel conditions.	**4 hours**
To simulate WLAN scenarios using different IEEE 802.11 standards and compare their performance in terms of throughput, delay, and coverage under varying network conditions (e.g., number of users, channel bandwidth, interference).	**2 hours**
Total Laboratory Hours	**30 hours**

Mode Evaluation : Continuous Assessment and Final Assessment Test.			
Recommended by Board of Studies			
Approved by Academic Council	**No.**	**Date**	

Course Code	**Course Title**	**L**	**T**	**P**	**C**
MAEIC501	**Machine Learning for Communication**	**3**	**0**	**2**	**4**
Pre-requisite			**Syllabus Version**		
			1.0		
Course Objectives					

1. Build fundamental concepts and techniques of Machine Learning. 2. Comprehend the different types of regression and data classification. 3. Train machine learning techniques for communication systems including vehicular communications, edge devices and IoT devices.		
Course Outcomes		
1. Apply different types of learning, identify data discrepancies and eliminate anomalies. 2. Analyze the outcomes based on unsupervised learning and supervised learning. 3. Construct reinforcement learning algorithms for advanced wireless communication applications. 4. Apply LSTM and RL algorithms for vehicular and UAV-assisted wireless communications. 5. Implement machine learning techniques for traffic prediction, resource allocation, and interference management in 5G cellular networks.		
Module:1	**Fundamentals of Machine Learning**	**8 hours**
Introduction to machine learning: supervised, unsupervised, and reinforcement learning; deep learning; Transformer learning. Revision of probability, statistics, and linear algebra. Data preprocessing techniques: cleaning, transformation, and dimensionality reduction. ML frameworks and libraries: TensorFlow, TensorFlow Lite, PyTorch, and scikit-learn. Introduction to Embedded Machine Learning: on-device inference, model compression, and hardware acceleration. Introduction to Edge Impulse.		
Module:2	**Regression, Classification, and Clustering**	**9 hours**
Linear Multi Linear Regression (MLR), Logistic Regression, Support Vector Machine (SVM), Random Forest (RF), Neural Networks: CNN and RNN. Baye's theorem-Parameter Estimation Distribution - Classifier Networks K-Nearest Neighbors. Application of CNN and RNN in wireless communications. Introduction to clustering, supervised learning after clustering, unsupervised learning methods for traffic prediction, clustering for 5G performance optimization, Federated Learning for decentralized mobile networks.		
Module:3	**Reinforcement Learning in Wireless Communications**	**9 hours**
Reinforcement Learning (RL), Bandit Algorithms, Deep Q-Learning (DQL), Proximal Policy Optimization (PPO), Multi-agent RL (MARL) for dynamic spectrum and resource management in cooperative communications, optimization techniques for dynamic spectrum access. Application of RL and DQL in adaptive beamforming in 5G communications. Applications in UAV-assisted communications.		
Module:4	**Machine Learning for Spectrum Access and Sharing**	**8 hours**
Online Learning Algorithms for Opportunistic Spectrum Access, Performance Measures of the Online Learning Algorithms, Random and Deterministic Approaches, the Adaptive Sequencing Rules Approach, Structure of Transmission Epochs, Learning Algorithms for Channel Allocation, Distributed Learning.		
Module:5	**Machine learning for Mobile Network Design**	**9 hours**

Supervised learning-assisted adaptive modulation and coding (AMC) using k-nearest neighbors, support vector machines (SVM), random forests, and neural networks. Deep learning for user grouping and clustering in D2D communication and heterogeneous networks to enable efficient traffic offloading in 5G systems. RL-based approaches for traffic prediction and interference management in heterogeneous networks. Clustering of small cells in heterogeneous deployments to reduce interference in coordinated multipoint transmission for 5G. Introduction to long short-term memory (LSTM) and its applications in vehicular communications.		
Module:6	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Books	
1	Kevin P. Murphy, Machine Learning: A Probabilistic Perspective, 2020, 2nd Edition, MIT Press.
2	Pete Warden and Daniel Situnayake, Machine Learning with TensorFlow Lite on Arduino and Ultra-Low-Power Microcontrollers, 2019, O'Reilly Media.
Reference Books	
1.	Fa-long Luo, Machine Learning for Future Wireless Communications, 2020, 1st Editon, Wiley-IEEE Press.
2.	Alpaydin Ethem, Introduction to Machine Learning, 2019, 3rd Edition, PHI learning private limited.
Mode of Evaluation: Quiz, Assignment, Design Project, Case Study, Seminar, CAT and FAT	

List of Experiments (Indicative)	
Performance analysis of linear regression and radial basis function with classifiers.	**4 hours**
Develop a supervised learning framework to decode binary data from noisy light sensor readings.	**2 hours**
Performance analysis of clustering based hierarchical supervised learning.	**2 hours**
Performance analysis of machine learning based adaptive modulation and coding schemes.	**2 hours**
Performance comparison of cognitive radio and machine learning based cognitive radio.	**2 hours**
Simulate mobile users moving across cells and use DQN to make handoff decisions to maximize connectivity and throughput.	**2 hours**
Wireless channel estimation using convolution neural network	**2 hours**
Traffic pattern prediction in wireless networks using LSTM and TinyML framework.	**2 hours**
Edge-based interference management in HetNet using federated learning and	**2 hours**

TinyML deployment.	
Deploying a simple ML model on Edge Impulse for signal classification in a wireless sensor node.	**2 hours**
Security analysis using TinyML for anomaly detection in wireless communication systems: Detecting network intrusions or malicious activities.	**2 hours**
ML-assisted beamforming optimization	**2 hours**
RL-assisted interference analysis on 5G data collected using USPR or 5G/6G HAT	**2 hours**
Develop a reinforcement learning agent on the edge device to classify its current indoor zone based on RSSI values from fixed BLE beacons, using rewards to improve zone prediction accuracy over time.	**2 hours**
Total Laboratory Hours	**30 hours**
Mode of Evaluation: Continuous Assessment and Final Assessment Test.	

Recommended by Board of Studies			
Approved by Academic Council	**No.**	**Date**	

Course Code	**Course Title**	**L**	**T**	**P**	**C**
MAEIC504	**Multimedia Communication Systems**	**3**	**1**	**0**	**4**
Pre-requisite		**Syllabus Version**			
		1.0			
Course Objectives					

1. Build the fundamental concepts of multimedia systems and explore various data compression algorithms for efficient representation and storage 2. Familiarize students with network services, protocols, and content distribution techniques essential for multimedia communication. 3. Comprehend the mechanisms of multimedia information sharing over wired, wireless, and social communication platforms, with an introduction to emerging MulSeMedia technologies.		
Course Outcomes		
1. Interpret the basic concepts and components of multimedia communication systems. 2. Classify various data and multimedia compression techniques used for efficient storage and transmission. 3. Apply network services and protocols to enable effective multimedia communication and content distribution over the Internet. 4. Demonstrate multimedia information-sharing mechanisms over wireless mobile networks and interpret their relevance in modern communication systems. 5. Relate the role of cloud computing, social media, and emerging mulsemedia technologies in enabling modern multimedia services and interactions.		
Module:1	**Fundamentals of Multimedia Systems**	**12 hours**
Introduction to Multimedia - Elements of multimedia. Key properties of multimedia Audio Technology – Audio representation on computers, Three-dimensional sound production, Music and the MIDI Standard. Graphics and Images: Capturing Graphics and images, Computer assisted graphics and image processing. Video Technology- Representation of Video Signals, Television systems, digitisation of video signals.		
Module:2	**Multimedia Data Compression**	**13 hours**
Lossless compression algorithms: Basics of information theory, Run-length coding, Shannon–Fano algorithm, Huffman coding, Arithmetic coding. Lossy compression algorithms: Quantization, Uniform and scalar quantization, Nonuniform scalar quantization, Vector quantization, Discrete cosine transform. Image compression Standards: JPEG Standard: Lossy Mode, Lossless mode. Video Compression Techniques: MPEG 1, MPEG 2		
Module:3	**Network Services, Protocols and Multimedia Content Distribution**	**12 hours**
Protocol layers of computer communication networks, Local area network and access networks, Internet technologies and protocols, Multicast extension, Quality-of-Service for multimedia communications, Protocols for multimedia transmission and interaction. Proxy caching, Content Distribution Networks (CDNs), Broadcast and Multicast video-on-demand, Broadcast/Multicast for heterogeneous users, HTTP-Based Media Streaming		

Module:4	Multimedia Transmission over Wireless Networks and Social Media Platforms	11 hours
Characteristics of wireless channels, Wireless networking technologies, Multimedia over wireless channels, Error detection, Error correction, Error-resilient coding, Error concealment, Social media sharing: Representative social media services, User-Generated media content sharing, Media propagation in online social networks		
Module:5	**Introduction to New Generation Multimedia Services**	**10 hours**
Cloud Computing for Multimedia Services: Cloud Computing Overview, Multimedia Cloud Computing, Cloud-Assisted Media Sharing, Introduction to MulSeMedia, Multisensory Presence in Virtual Reality: Possibilities & Limitations, Multiple Sensorial Media and Presence in 3D Environments		
Module:6	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Books	
1	Z.N. Li, M.S. Drew, J. Liu, Fundamentals of multimedia, 2021, 3rd edition, Springer, Cham Heidelberg, New York, Dordrecht, London.
2	Ghinea, G.; Andres, F.; and Gulliver, S., Multiple Sensorial Media Advances and Applications: New Developments in MulSeMedia, 2020, Premier Reference Source, India
Reference Books	
1.	K.R. Rao, Z.S., Bojkovic, D.A. Milovanovic, Multimedia Communication Systems: Techniques, Standards, and Networks, 2002, 1st Edition, Prentice Hall PTR.
2.	Ralf Steinmetz and Klara Nahrstedt, Multimedia Fundamentals, 2002, IMSC Press, India
3.	J. D. Gibson, Multimedia Communications: Directions and Innovations, 2020, Springer, India

Mode of Evaluation: Quiz, Assignment, Design Project, Case Study, Seminar, CAT and FAT

Approved by Academic Council	No.	Date	

Course Code	Course Title	L	T	P	C
MAEIC505	Embedded C Programming	2	0	4	4
Pre-requisite		Syllabus Version			
		1.0			

Course Objectives

1. Introduce the fundamentals of Embedded C programming and familiarize students with its syntax, structure, and usage in embedded system design.
2. Enable students to develop and test C programs for microcontroller architectures like 8051 and ARM Cortex-M4 (STM32F4) using software tools.

3. Build practical skills in programming microcontroller peripherals like GPIO, timers, UART, interrupts, and DMA, and to gain hands-on experience with FreeRTOS for developing real-time embedded applications.		
Course Outcomes		
1. Apply C programming concepts such as arrays, functions, pointers, and bitwise operations in embedded system applications. 2. Implement port operations, timer-based delays, and serial communication routines on the 8051 microcontroller using C programming. 3. Demonstrate interrupt-driven control and peripheral interfacing with devices such as keypads, sensors, LCDs, and displays using the 8051. 4. Develop embedded applications by configuring GPIOs, timers, interrupts, communication protocols and low-level peripherals using STM32F4 and real-time multitasking with FreeRTOS. 5. Design embedded solutions using C programming on both 8051 and STM32F4 microcontrollers for real-world applications.		
Module:1	**Embedded C Fundamentals**	**4 hours**
Embedded system design process, Differences between general-purpose and embedded programming, , Data types, operators, expressions, Conditional statements (if-else, switch), Control statements(loops), Arrays, Strings, Functions and Pointers, bitwise operations, preprocessors, storage classes and qualifiers (define, volatile, const, static).		
Module:2	**8051 Programming in C**	**6 hours**
8051 Architecture, Pin configuration, Programs on working with 8051 ports, programs on logic operations, data conversion, programs on time delay generation, PWM signals and counters. programs on transmitting and receiving data with different baud rates.		
Module:3	**8051 Interrupts and Interfacing**	**6 hours**
8051 interrupts and interrupt registers; programming using timer and serial communication interrupts. Interfacing and programming of a 4×4 matrix keypad, seven-segment displays and writing code for numeric display, 16×2 LCD display,. Interfacing basic sensors such as temperature (LM35), light (LDR), and IR sensors.		
Module:4	**ARM Programming with STM32F4**	**6 hours**
Importance of ARM, ARM licensing model and processor families, ARM Cortex-M4 core architecture, Pin configuration, CMSIS, HAL headers, and register access macros , GPIO architecture and programming using HAL and registers, Bit-banding, masking, and, low-level register I/O, Programming timers for time delays, PWM signal generation, Timers as event counters.		
Module:5	**Peripheral Programming and Real-Time Applications on STM32F4**	**6 hours**

NVIC and interrupt vector table, external interrupt configuration, , UART basics and configuration, Polling-based and interrupt-based UART communication, DMA architecture, DMA with UART transmission and reception, I2C peripheral initialization and data transfer, SPI communication basics. Introduction to RTOS and FreeRTOS concepts, Task creation, task priorities, Task notification from ISR, Simple multitasking programs using FreeRTOS.		
Module:6	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**30 hours**

Text Books

1	M. A. Mazidi, J. G. Mazidi, and R. D. McKinlay, *The 8051 Microcontroller and Embedded Systems: Using Assembly and C*, Pearson New International Edition, Pearson Education, 2014.
2	Carmine Noviello, *Mastering STM32*, 1st Edition, Leanpub, 2017

Reference Books

1.	Myke Predko, *Programming and Customizing the 8051 Microcontroller*, 1st Edition, McGraw-Hill, 2000.
2.	Joseph Yiu, *The Definitive Guide to ARM Cortex-M3 and Cortex-M4 Processors*, 3rd Edition, Newnes, 2014.
3.	Sofie Beerens, *C for Embedded Systems*, CRC Press, 2000.

Mode of Evaluation: Quiz, Assignment, CAT and FAT

List of Experiments (Indicative)

1. C programs on conditional statements and loops	**4 hours**
2. C programs on arrays, strings, pointers and functions	**4 hours**
3. Embedded C programs on working with 8051 ports and timers	**6 hours**
4. Embedded C programs on working with 8051 counters and serial communication	**6 hours**
5. Embedded C programs on 8051 interrupt handling	**6 hours**
6. Embedded C programs on interfacing keypad, seven-segment, and LCD displays with 8051	**6 hours**
7. Embedded C programs on toggling LEDs and reading inputs using GPIOs on STM32F4 (HAL & register access)	**6 hours**
8. Embedded C programs on STM32F4 timers for PWM signal generation and delay	**6 hours**
9. Embedded C programs on STM32F4 UART communication using interrupts and DMA	**8 hours**
10. Embedded C programs on I2C communication and multitasking using FreeRTOS on STM32F4	**8 hours**

Total Laboratory Hours	**60 hours**
Mode Evaluation : Continuous Assessment and Final Assessment Test.	
Recommended by Board of Studies	
Approved by Academic Council	**No.**	**Date**

Course Code	**Course Title**	**L**	**T**	**P**	**C**
MAEIC506	**Internet of Things**	**3**	**0**	**2**	**4**
Pre-requisite	**NA**	**Syllabus Version**			

		1.0
Course Objectives		
1. Explore the characteristics of Internet of things, architecture, and protocols. 2. Acquaint students with various platforms and value engineering analysis for designing real-life IoT use cases. 3. Impart knowledge on IoT data models and familiarize the concepts of data mining and Machine learning for IoT applications.		
Course Outcomes		
1. Assimilate the technologies that enable IoT and interpret different components in IoT architecture with communication protocols and its significance. 2. Envision hardware, software and cloud platforms used for IoT. 3. Envision different data models and value analysis for cost-effective design of IoT applications. 4. Perceive data analytics tools and gain knowledge on ML techniques for IoT. 5. Apply knowledge of IoT by interfacing sensors and actuators with microcontrollers, and understand the process of transmitting data to cloud platforms for real-time analysis.		
Module:1	**Internet of Things and Architecture**	**9 hours**
IoT Definition, Characteristics of IoT, IoT Ecosystem, IoT enabling Technologies, Planning for IoT solutions, IoT Architecture reference model, Layered Architecture for IoT: Three Layered and Five Layered architecture. Impact of IoT in Communication, business, and society.		
Module:2	**IoT Protocol Suite**	**8 hours**
Communication models and Communication APIs for IoT, MAC protocols for Sensor network, IEEE 802 series protocols, NFC, RFID, BLE, IPv4/IPv6, 6LoWPAN, LoRaWAN, MQTT, CoAP, XMPP, AMQP, DDS, RPL.		
Module:3	**Platforms for IoT applications and Security**	**9 hours**
Sensors, Actuators, MCUs, Sensor Data Gateway, Cloud Platforms, IoT Data Analytics Platforms, IoT Data Visualization, Open source platforms. Security issues and mechanisms in different layers of IoT, Technologies and methods that mitigate security, Privacy issues, Standards, and regulations.		
Module:4	**Data mining and Smart Data Analytics**	**9 hours**
Introduction to Data mining, Applications of data mining, Need for Data Preprocessing - Data Cleaning, Data Integration, Data Transformation, Data Reduction, Handling imbalanced real time datasets, Handling Outliers. Significance of Exploratory Data Analysis, Need for Machine Learning in IoT.		
Module:5	**Design to Value in IoT**	**8 hours**
SDLC, Development Models – Waterfall, Rapid Application Development, Agile models, Spiral Models, Principles and Phases of Value Engineering and Analysis in IoT Solutions, Cost Function Analysis in IoT Solutions, Assets for IoT Solution Development, Reusability Plans		
Module:6	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 hours**
Text Books		
1	Arshdeep Bahga, Vijay Madisetti, "Internet of Things: A hands-on Approach", Universities Press,	

	2015.
2	Hwaiyu geng, “Internet of Things and Data Analytics – Handbook”, Wiley, 2017.
Reference Books	
1.	Ammar Rayes,Samer Salam, “ Internet of Things from Hype to Reality- A road to Digitization” Second Edition, Springer, ISBN 978-3-319-99515-1.
2.	Rajkumar Buyya,Amir Vahid “ Internet of Things Principles and Paradigms”, Elsevier, 2016.
3.	Picone M, Cirani S, Ferrari G., Veltri L., Internet of Things: Architectures, Protocols and Standards, 2018, Wiley, United Kingdom.
4.	Dey, Hassanien, Bhatt, Ashour and Satapathy, Internet of Things and Big Data Analytics towards Next-Generation Intelligence, Springer, 2018.
Mode of Evaluation: Quiz, Assignment, Design Project, CAT and FAT	
List of Experiments (Indicative)	

Intelligent Traffic light control system	**2 hours**
Air Quality monitoring system with cloud interface	**2 hours**
Smart Irrigation system with cloud interface	**4 hours**
Mobile/web application for IoT enabled water quality monitoring.	**2 hours**
Develop an IoT based solution to automate real-world problem.	**4 hours**
Implement Sample Edge Gateway based IoT Solution	**2 hours**
Handle real world datasets appropriately for IoT use cases	**2 hours**
Demonstrate data visualization for real-world datasets.	**4 hours**
Build web based application to automate door using facial recognition.	**4 hours**
Deployment of end to end IoT Applications with Cloud	**4 hours**
	30 hours
Mode Evaluation: Continuous Assessment and Final Assessment Test.	

Recommended by Board of Studies			
Approved by Academic Council	**No.**	**Date**	

Course Code	**Course Title**	**L**	**T**	**P**	**C**
MAEIC601	**5G New-Radio Architecture, Protocols, and Deployment**	**3**	**0**	**0**	**3**
Pre-requisite		**Syllabus Version**			

		1.0
Course Objectives		
1. Compare the 5G network architecture, core, components, and air interface with traditional networks. 2. Explain the 5G protocols and data flow mechanisms to optimize communication. 3. Identify the deployment scenarios and technologies to improve 5G network performance.		
Course Outcomes		
1. Compare 5G and traditional network architectures, highlighting the essential components and their functional roles. 2. Illustrate the concepts of the 5G air interface, including numerology, resource blocks, and waveform design. 3. Describe the 5G RAN protocol stack and the role of DMRS, CSI-RS, and SRS in communication and channel optimization. 4. Explain the 5G core architecture, its network configuration and optimization functions, and the impact of call flows, identities, and deployment options on 5G network design.		
Module:1	**5G System Architecture**	**7 hours**
5G Standards & 3GPP Technical Specifications Groups; Use Cases; Requirements; Network Architecture-Traditional vs. 5G; Base Station Architectures-Standalone (SA) vs. Non-Standalone (NSA); Transport Network Architecture; Interfaces; Protocol Stacks-User Plane, Control Plane; Network Slicing; Spectrum-Subcarrier Selection, Spectrum Utilization; Peak Data Rate-Different Modes; User Plane Latency; Stages of Radio Access Network (RAN) Evolution; Open RAN and O-Cloud.		
Module:2	**Air Interface**	**9 hours**
Numerology; Radio Frames and Slots; Resource Blocks and Bandwidth Parts-Common Resource Blocks, Bandwidth Parts, Physical Resource Blocks, Virtual Resource Blocks; Channel Bandwidths; Antenna Ports and Quasi Co-Location; Modulation and Coding Schemes; Waveform-CP-OFDM, Transmitter and Receiver Chain; Duplex Schemes.		
Module:3	**Protocol Stack and Reference Signals**	**9 hours**
5G RAN Protocol Stack; Layer 1: Overview of Physical Layer Downlink, Physical Downlink Control Channel (PDCCH), Physical Downlink Shared Channel (PDSCH); Overview of Physical Layer Uplink, Physical Uplink Control Channel (PUCCH), Physical Uplink Shared Channel (PUSCH); Layer 2: Data Flow, Functions-Radio Link Control (RLC), Medium Access Control (MAC), Packet Data Convergence Protocol (PDCP), Service Data Adaptation Protocol (SDAP); Layer 3: Radio Resource Control (RRC) and its States, Radio Protocol Architecture. Reference Signals: Demodulation Reference Signal (DMRS) for Channel Estimation and Demodulation, Channel State Information (CSI) Acquisition for Precoding and Link Adaptation with CSI-Reference Signal (CSI-RS), Sounding Reference Signal (SRS) for Uplink Channel Sounding and Beam Management.		
Module:4	**5G Core (5GC)**	**9 hours**

Course Code	Course Title	L	T	P	C
MAEIC602	Signal Processing Algorithms	3	0	0	3
Pre-requisite		Syllabus Version			

Core Network Architecture; Service-Based Architecture (SBA); SBA Functions-Access and Mobility Function (AMF); Session Management Function (SMF); User Plane Function (UPF); Policy Control Function (PCF); Unified Data Management (UDM); Network Data Analytics Function (NWDAF); Network Slice Selection Function (NSSF); Network Repository Function (NRF); Network Function Virtualization. Management and Orchestration; Software Defined Networking and Deployment.		
Module:5	**Call Flows, Identities and Deployment Scenarios**	**9 hours**
5G Initial Access and Registration Procedure-Random Access Procedure (RACH); De-Registration Procedures; Subs and Device Identities-Subscription Permanent Identifier (SUPI), Subscription Concealed Identifier (SUCI), Globally Unique Temporary Identifier (GUTI); Permanent Equipment Identifier (PEI); Protocol Data Unit (PDU) Session Establishment; UE Identities; Network Identities; 5G Deployment Options; Early 5G Deployment-NSA with LTE Anchor (Option 3), NSA with NR Anchor (Option 7), Advanced 5G Deployment-SA with NR and 5GC (Option 4), SA; Multi-Connectivity; Secondary Node Additions; Beamforming and Coverage; Coverage Planning; Beam Sweeping; Antenna Configuration and Selection.		
Module:6	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Books

1	Zaidi, Ali, Fredrik Athley, Jonas Medbo, Ulf Gustavsson, Giuseppe Durisi, and Xiaoming Chen, 5G Physical Layer: Principles, Models and Technology Components, 2018, 1st Edition, Academic Press, United States.
2	Launay, Frederic. NG-RAN and 5G-NR: 5G Radio Access Network and Radio Interface, 2021 John Wiley & Sons, 1st Edition, United States.

Reference Books

1.	Ahmadi, Sassan, 5G NR: Architecture, Technology, Implementation, and Operation of 3GPP New Radio Standards, 2019, 1st Edition, Academic Press, United Kingdom.
2.	Suvra Sekhar Das, Ramjee Prasad, Evolution of Air Interface Towards 5G Radio Access Technology and Performance Analysis, 2018, 1st Edition, River Publishers, Denmark.
3.	Chris Johnson, 5G New Radio in Bullets, 2019, 1st Edition, England.

Mode of Evaluation: Quiz, Assignment, Case Study, Seminar, CAT and FAT

Recommended by Board of Studies			
Approved by Academic Council	**No.**	**Date**	

		1.0
Course Objectives		
1. Familiarize the concepts of deterministic signals and systems as well as random signals 2. Build foundation for concepts of linear signal models and optimum linear filters 3. Comprehend the concepts of least-squares and adaptive filters.		
Course Outcomes		
1. Acquire a working knowledge of deterministic and random signals and the principles governing their processing by linear systems. 2. Explore the implementation of optimum linear filters using recursive algorithm concepts. 3. Implement filters based on the concept of linear least-squares to realize LMS and RLS models 4. Apply algorithms for spectral estimation for various applications		
Module:1	**Fundamentals of discrete time signals, Random variables, vectors and sequences**	**9 hours**
Discrete time signals, Transform domain representation of deterministic signals, Discrete-time systems, Minimum phase and system invertibility. Random variables, Random vectors, Discrete time stochastic processes, Linear systems with stationary random inputs, Innovation representation of random vectors		
Module:2	**Optimum Linear Filters**	**9 hours**
Optimum signal estimation, Linear least square and mean square error estimation, Solution of normal equations- Optimum FIR filter, Linear prediction, Optimum IIR filters, Inverse filtering and de-convolution, Channel equalization of data transmission systems, Matched filters, Wiener filters, and Eigen filters		
Module:3	**Algorithms and Structures for optimum linear filters**	**9 hours**
Fundamentals of order, recursive algorithms, Interpretation of algorithmic quantities, Order-recursive algorithms for optimum FIR filters, Levinson and Levinson- Durbin algorithms, Step-Up and Step-Down algorithms		
Module:4	**Adaptive Filters**	**8 hours**
Principles of adaptive filters, Method of steepest decent, LMS adaptive filters, RLS adaptive filters, Fast RLS algorithms for FIR filtering		
Module:5	**Spectral Estimation and optimization**	**8 hours**
Non-parametric – parametric & sub-space-based algorithms- Array processing – beam forming-Side lobe cancellers – space-time process, Iterative algorithms – convex optimization - Gradient, stochastic gradient – Expectation Maximization.		
Module:6	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 hours**
Text Books		

1	Papoulis.A and Pillai S.U, Probability, Random Variables and Stochastic Processes, 2017, 4th Edition, McGraw Hill Education.
2.	Anastasia Veloni, Nikolaos Miridakis, Erysso Boukouvala, Digital and Statistical Signal Processing, 2020, 1st Edition, CRC Press, Boca Raton.
Reference Books	
1.	Simon Haykin, Communication Systems, 2019, 5th Edition, Wiley, India
2.	Steven. M. Kay, Modern Spectral Estimation: Theory & Application, 2009, Pearson Education India
Mode of Evaluation: Quiz, Assignment, Design Project, Case Study, Seminar, CAT and FAT	

Course Code	**Course Title**	**L**	**T**	**P**	**C**
MAEIC603	**Network Security**	**3**	**0**	**2**	**4**
Pre-requisite		**Syllabus Version**			
		1.0			
Course Objectives					

1. Provide a strong foundation in the mathematical and theoretical principles underlying classical and modern cryptographic algorithms. 2. Equip classical and quantum cryptographic methods for secured communication systems. 3. Equip students with the ability to apply contemporary protocols and intelligent systems for detecting, preventing, and mitigating security threats in modern networks.		
Course Outcomes		
1. Solve complex problems in cryptographic systems using number theory, modular arithmetic, and probability concepts. 2. Utilize symmetric and asymmetric cryptographic techniques to achieve confidentiality, integrity, and authentication in secure communications. 3. Apply secure communication protocols and machine learning techniques to detect and mitigate network security threats. 4. Apply quantum cryptographic mechanisms in securing communications. 5. Demonstrate cryptographic protocols and intrusion detection mechanisms to identify vulnerabilities and assess security effectiveness.		
Module:1	**Mathematical Foundations for Network Security**	**9 hours**
Overview of network security: goals, threats, and attack types - Security services and models: CIA triad, Bell-LaPadula, Biba, Clark-Wilson - Number theory: modular arithmetic, GCD, Euler's and Fermat's theorems, primes - Discrete logarithm problem - Finite fields and polynomial arithmetic - - Probability, entropy, and one-way functions		
Module:2	**Symmetric Cryptography and Message Authentication**	**9 hours**
Block ciphers: DES, AES and their Cryptanalysis, S-boxes, key schedule - Modes of operation: ECB, CBC, CFB, OFB, CTR, GCM - Stream ciphers and random number generators - Hash functions: SHA-512, MD-5 - Message Authentication Codes (MACs): HMAC, CBC-MAC		
Module:3	**Asymmetric Cryptography and Key Management**	**9 hours**
RSA: key generation, encryption, decryption - Diffie–Hellman key exchange - ElGamal encryption -Elliptic Curve Cryptography (ECC): ECC-DH, ECDSA - Digital signatures: RSA-DSA, ECDSA - Public Key Infrastructure (PKI): certificates and trust models		
Module:4	**Intelligent Network Security Protocols**	**9 hours**
Secure communication protocols: TLS/SSL, IPsec, SSH, PGP, S/MIME - Authentication: Kerberos, OAuth 2.0, EAP - Zero Trust Architecture, VPNs, tunneling techniques - Intrusion Detection Systems (IDS): signature and anomaly-based - Machine learning in threat detection: supervised and unsupervised models		
Module:5	**Quantum and Post-Quantum Cryptography**	**7 hours**
Quantum computing basics: qubits, superposition, entanglement - Quantum Key Distribution (QKD): BB84 protocol - Quantum threats to RSA, ECC, DH - Post-quantum cryptography: lattice-based, hash-based, code-based - NIST standardization efforts		
Module:6	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 hours**
Text Books		

1.	William Stallings, Cryptography and Network Security: Principles and Practice, 2023, 8th Edition, Pearson, India
2.	Thomas Vidick and Stephanie Wehner, Introduction to Quantum Cryptography, 2023, 1st Edition, Cambridge University Press, UK
Reference Books	
1.	Jonathan Katz and Yehuda Lindell, Introduction to Modern Cryptography, 2021, 3rd Edition, CRC Press, USA
2.	Niels Ferguson, Bruce Schneier, and Tadayoshi Kohno, Cryptography Engineering: Design Principles and Practical Applications, 2022, Reprint, Wiley, USA
3.	Chwan-Hwa (John) Wu and J. David Irwin, Introduction to Computer and Network Security: Navigating Shades of Gray, 2021, 1st Edition, CRC Press, USA
Mode of Evaluation: Quiz, Assignment, Design Project, CAT and FAT	
List of Experiments (Indicative)	

Modular Arithmetic and GCD using Euclidean Algorithm	**2 hours**
Prime Number Generation and Fermat's Primality Test	**2 hours**
AES Simulation in ECB and CBC Modes with Key Scheduling	**2 hours**
Stream Cipher Implementation using LFSR	**2 hours**
SHA-512 Implementation and Avalanche Effect Analysis	**2 hours**
Message Authentication Code Generation using HMAC and CBC-MAC	**2 hours**
RSA: Key Generation, Encryption, and Decryption	**2 hours**
Diffie–Hellman Key Exchange Simulation	**2 hours**
ECC-Based Digital Signature (ECDSA) Implementation	**2 hours**
TLS Protocol Handshake Simulation	**2 hours**
Anomaly-Based Intrusion Detection using Statistical Thresholding	**2 hours**
Supervised Machine Learning for Intrusion Detection	**2 hours**
BB84 Quantum Key Distribution Protocol Simulation	**2 hours**
E91 Quantum Key Distribution Protocol Simulation	**2 hours**
Lattice-Based Post-Quantum Key Exchange Simulation	**2 hours**
Total Laboratory Hours	**30 hours**
Mode of Evaluation: Quiz, Assignment, Design Project, CAT and FAT	

Recommended by Board of Studies			
Approved by Academic Council	**No.**	**Date**	

Course Code	**Course Title**	**L**	**T**	**P**	**C**
MAEIC604	**System on Chip with Verilog HDL**	**3**	**0**	**2**	**4**
Pre-requisite		**Syllabus Version**			
		1.0			
Course Objectives					

1. Understand the concepts of SoC design flow and the key components involved in wireless

<table>
<tr><td colspan="3">system architectures.
2. Equip students with design and HDL coding skills including DSP and control modules used in wireless communication.
3. Introduce the integration techniques for processor cores, memory, and peripherals to build functional SoCs for wireless applications.</td></tr>
<tr><td colspan="3">Course Outcomes</td></tr>
<tr><td colspan="3">1. Apply SoC design principles to analyse and develop wireless system architectures incorporating processor cores, memory, and interconnects.
2. Use Verilog HDL to develop and simulate hardware modules through various modeling styles.
3. Realize hardware modules such as DSP filters, modulation and demodulation modules, and finite state machines for wireless communication protocols.
4. Interpret the integration of processor cores, memory, DSP accelerators, and peripherals using bus systems to build efficient wireless SoCs.
5. Use simulation and synthesis tools to design, verify, and implement hardware on FPGA/SoC platforms.</td></tr>
<tr><td>Module:1</td><td>Overview of SoC in Wireless Systems</td><td>9 hours</td></tr>
<tr><td colspan="3">ASIC to SoC - SoC design flow - Overview of SoC components: processor core, memory, peripherals, interconnects - IP core reuse and integration - Role of SoC in wireless devices - Architecture of a typical wireless SoC - Wireless protocol layers: Physical (PHY), MAC, and Network.</td></tr>
<tr><td>Module:2</td><td>Basics of Verilog HDL</td><td>9 hours</td></tr>
<tr><td colspan="3">Verilog syntax and semantics - Module definition, ports, and hierarchy - Operators - Dataflow Modeling, Behavioural Modeling - blocking vs. non-blocking assignments - Structural modelling - Synthesis constraints, and Test Bench.</td></tr>
<tr><td>Module:3</td><td>RTL Design with Verilog</td><td>7 hours</td></tr>
<tr><td colspan="3">Timing constraints and design optimization - DSP blocks: FIR and IIR filters, FFT and IFFT modules – Modulation and demodulation blocks - Channel coding and decoding - Finite state machines (FSMs) for MAC layer control</td></tr>
<tr><td>Module:4</td><td>SoC Design for Wireless Communication</td><td>9 hours</td></tr>
<tr><td colspan="3">Baseband processor integration - Integrating memory, DMA controllers, and timers - Custom accelerators for DSP blocks - Clock domains and synchronization in RF systems</td></tr>
<tr><td>Module:5</td><td>SoC Building Blocks</td><td>9 hours</td></tr>
<tr><td colspan="3">Processor core integration - Memory integration - Peripheral interfaces - Bus systems for high-throughput baseband data transfer</td></tr>
<tr><td>Module:6</td><td>Contemporary Issues</td><td>2 hours</td></tr>
<tr><td colspan="3"></td></tr>
<tr><td></td><td>Total Lecture hours:</td><td>45 hours</td></tr>
<tr><td colspan="3">Text Books</td></tr>
</table>

1	V. Chakravarthi, A Practical Approach to VLSI System on Chip (SoC) Design: A Comprehensive Guide, 2022, 2nd Edition, Springer.
2	Haesik Kim, Wireless Communications Systems Design, 2015, 1st Edition, Wiley

Reference Books

1.	David J. Greaves, Modern System-on-Chip Design on Arm, 2021, 2nd Edition, ARM Education media
2.	J. Bhasker, A Verilog HDL Primer, 2018, Third Edition, Star Galaxy Publishing

Mode of Evaluation: Quiz, Assignment, Design Project, Case Study, Seminar, CAT and FAT

List of Experiments (Indicative)

Design and implement a baseband filters.	**4 hours**
Design and implement of baseband modulation and demodulation block	**4 hours**
Design and implement simple channel encoding technique	**4 hours**
FSM implementation for MAC protocol	**4 hours**
Design and implement peripheral interface - UART, SPI, I2C, GPIO	**4 hours**
Implement of complex design – AXI, AHB, APB, Wishbone bus protocol	**4 hours**
SoC for a custom wireless communication system (e.g., simple OFDM transceiver)	**6 hours**
Total Laboratory Hours	**30 hours**

Mode Evaluation: Continuous Assessment and Final Assessment Test.

Recommended by Board of Studies			
Approved by Academic Council	**No.**	**Date**	

Course Code	**Course Title**	**L**	**T**	**P**	**C**
MAEIC605	**Wireless Sensor Networks**	**3**	**0**	**0**	**3**
Pre-requisite	**Nil**	**Syllabus Version**			
		1.0			

Course Objectives

1. Comprehend the fundamentals of Wireless Sensor Networks and their real-time applications.
2. Build foundation on various layers and standards applicable for Wireless Sensor Networks.
3. Explain the performance issues pertaining to design of Wireless Sensor Networks.

Course Outcomes

1. Explain WSN architecture and its protocol stack.
2. Describe the Physical layer standard and MAC Layer protocols.
3. Build the various Routing protocols used in WSN.
4. Identify the various Transport layer, Application layer protocols, localization techniques and performance Management.

Module:1	**Introduction to Sensor Networks**	**5 hours**
Sensor mote platforms, WSN Architecture and protocol stack, Applications of Wireless Sensor Networks, Factors influencing WSN design.		
Module:2	**PHY layer and MAC Protocols**	**10 hours**
Physical layer technologies, Modulation, Wireless channel effects, PHY layer standard-IEEE 802.15.4, Zigbee. MAC, Challenges in MAC, CSMA mechanism, Contention based medium access, Reservation based medium access, Schedule based protocols - Sensor-MAC, Error Control.		
Module:3	**Network Layer**	**8 hours**
Routing Challenges and Design Issues in Wireless Sensor Networks, Data centric and flat architecture, Hierarchical protocols, Geographical routing.		
Module:4	**Transport Layer and Application Layer**	**10 hours**
Traditional Transport Control Protocols, Design Issues in Wireless Sensor Networks, Congestion Detection and Avoidance Protocol (CODA), Event-to-Sink Reliable Transport Protocol (ESRT), Performance of Transport Control Protocols. Source coding; Query Processing, Network Management, Interlayer effects, Cross layer interactions.		
Module:5	**Localization and Performance Management**	**10 hours**
Challenges in localization, Ranging techniques, Range-based localization, Range-free localization. Operating Systems and Execution Environments. Performance Modelling of WSNs, Case Study: Simple Computation of the System Life Span.		
Module:6	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Books	
1	Ian F. Akyildiz, Mehmet Can Vuran, Wireless Sensor Networks, 2010, 1st Edition, John Wiley & Sons Ltd.
2	Kazem Sohraby, Daniel Minoli, Taieb Znati, Wireless Sensor Networks-Technology, Protocols, and Applications, 2007, 1st Edition, John Wiley & Sons Ltd
Reference Books	
1.	Rastko R. Selmic, Vir V. Phoha, Abdul Serwadda, Wireless Sensor Networks-Security, Coverage, and Localization, 2016, 1st Edition, Springer International Publishing.
2.	Holger Karl, Andreas Wiilig, Protocols and Architectures for Wireless Sensor Networks, 2011, 1st Edition, John Wiley & Sons Ltd.
3	Waltenegus Dargie, Christian Poellabauer , "Fundamentals of Wireless Sensor Networks, Theory and Practice", Wiley Series on wireless Communication and Mobile Computing, 2011
4	Feng Zhao, Leonidas Guibas, Jie Liu, "Wireless sensor networks ", Elsevier publication - 2017
Mode of Evaluation: Quiz, Assignment, Design Project, Case Study, Seminar, CAT and FAT	

Mode Evaluation : Continuous Assessment and Final Assessment Test.		
Recommended by Board of Studies		
Approved by Academic Council	No.	Date

Course Code	Course Title	L	T	P	C
MAEIC606	Smart Antennas	3	0	2	4
Pre-requisite	NIL	Syllabus Version			

<table>
<tr><td></td><td colspan="2"></td><td>1.0</td></tr>
<tr><td colspan="4">Course Objectives</td></tr>
<tr><td colspan="4">1. Introduce the basic concepts and properties of smart antennas.
2. Familiarize the environmental parameters and smart antenna algorithms.
3. Understand the requirements for the design and implementation of smart antenna systems</td></tr>
<tr><td colspan="4">Course Outcomes</td></tr>
<tr><td colspan="4">1. Interpret the performances of switched beam, adaptive antenna systems.
2. Understand the smart antenna transmitter and receiver architecture.
3. Apply the direction of arrival estimation for smart antenna systems.
4. Interpret the environmental parameters for signal processing of smart antenna systems.
5. Design and implement smart antenna systems.</td></tr>
<tr><td>Module:1</td><td colspan="2">Fundamental of Smart Antenna</td><td>8 Hours</td></tr>
<tr><td colspan="4">Fundamental Parameters of Antennas, Differences Between Traditional and Smart Antennas, Need for smart antennas, Smart antenna configurations, Switched-Beam antennas, Adaptive antenna approach, Smart Antennas in Wireless Communication Systems, Architecture of a Smart antenna system, Basic principles: Advantage and Disadvantage, Receiver, Transmitter.</td></tr>
<tr><td>Module:2</td><td colspan="2">Direction-of-Arrival Estimation (DOA)</td><td>8 Hours</td></tr>
<tr><td colspan="4">Introduction, Array response vector, Received signal model, Subspace-based data model, Signal Autocovariance, Conventional DOA estimation methods, Capon's Minimum variance method, Subspace approach to DOA estimation, MUSIC algorithm, ESPRIT algorithm, Uniqueness of DOA estimates.</td></tr>
<tr><td>Module:3</td><td colspan="2">Beamforming Techniques</td><td>10 Hours</td></tr>
<tr><td colspan="4">Classical beam former, statistically optimum beamforming weight vectors, Maximum SNR beam former, Multiple side lobe canceller and Maximum SINR beam former, Minimum mean square error (MMSE), Direct Matrix Inversion (DMI), Linearly Constrained Minimum Variance (LCMV), Adaptive algorithms for beamforming, Role of AI and Machine Learning in Beam Forming</td></tr>
<tr><td>Module:4</td><td colspan="2">Smart Antennas in Modern Wireless Networks</td><td>10 Hours</td></tr>
<tr><td colspan="4">Smart Antennas in 5G and Beyond, Massive MIMO Systems and Millimeter-Wave Antennas, Performance Improvement in Cellular and Satellite Communications, Smart Antennas for IoT and Sensor Networks, Security and Interference Management Strategies</td></tr>
<tr><td>Module:5</td><td colspan="2">Future Trends of Smart Antennas</td><td>7 Hours</td></tr>
<tr><td colspan="4">Smart Antenna Implementation in Software-Defined Radio (SDR), Hardware Considerations and Testing Strategies, Case Studies: Real-World Deployments of Smart Antennas, Research Challenges and Opportunities in Smart Antenna Design, Applications of RIS in smart Antennas,</td></tr>
<tr><td>Module:6</td><td colspan="2">Contemporary Issues</td><td>2 hours</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td></td><td colspan="2">Total Lecture hours:</td><td>45 hours</td></tr>
<tr><td colspan="4">Text Books</td></tr>
<tr><td>1</td><td colspan="3">Constantine A. Balanis & Panayiotis I. Ioannides, Introduction to Smart Antennas,</td></tr>
</table>

	2022, 1st Edition, Springer Cham, Switzerland.
2	Joseph C. Liberti Jr., Theodore S. Rappaport, Smart Antennas for Wireless Communications *IS-95 and Third Generation CDMA Applications*, 1999, 1st Edition, PTR – PH publishers

Course Code	Course Title	L	T	P	C
MAEIC607	Optical Networks	3	0	0	3
Pre-requisite		Syllabus Version			

Reference Books	
1.	Lal Chand Godara, Smart Antennas, 2004, CRC Press.
2.	Frank Gross, Smart Antennas with MATLAB, 2015, McGraw-Hill Professional.
Mode of Evaluation: Quiz, Assignment, Design Project, CAT and FAT	

List of Experiments (Indicative)	
Design of dipole antenna based Phased array Antenna using Electromagnetic (EM) Simulation software.	**4 Hours**
Microstrip Patch Antenna and their Array Configuration using EM Simulation software.	**2 Hours**
Scanning Performances of Phased Array Antenna and their design using EM Simulation software.	**4 Hours**
Design of 2-way Power divider for Array fed network using EM Simulation software.	**2 Hours**
Design of 4-way Power divider for Array fed network using EM Simulation software.	**4 Hours**
To estimate the directions of arrival (DoAs) of multiple narrowband signals using the ESPRIT algorithm in MATLAB and accurately determine the incoming angles from simulated array data.	**4 Hours**
To estimate the directions of arrival (DoAs) of multiple narrowband signals using the MUSIC algorithm in MATLAB.	**4 Hours**
To implement the LMS algorithm in MATLAB for adaptive noise cancellation and evaluate the convergence behavior and error reduction performance.	**2 Hours**
To train and evaluate a supervised machine learning model in MATLAB for estimating the direction of arrival (DoA) of narrowband signals from simulated antenna array data.	**2 Hours**
Beam Analysis of Antenna's radiation pattern in anechoic chamber.	**2 Hours**
Total Laboratory Hours	**30 hours**
Mode Evaluation : Continuous Assessment and Final Assessment Test.	

Recommended by Board of Studies			
Approved by Academic Council	**No.**	**Date**	

		1.0

Course Objectives

1. Review the concepts of optical networking, network architectures, topologies
2. Familiarize the concepts of Switching, access end networks and 5G and Fiber-wireless convergence
3. Explore the use of Artificial Intelligence in Optical Networks

Course Outcomes

1. Comprehend the SONET network multiplexing, Topologies and Protection architectures
2. Identify the WDM components, expound wavelength routed networks and routing algorithms.
3. Explain Optical packet switching and optical access network technologies and their design.
4. Apprehend Optical Networking for 5G and Fiber - wireless convergence and the role of Artificial Intelligence for enhancing the performance of Optical Networks.

Module:1	**Digital Optical Networks**	**7 hours**
Synchronous optical networks (SONET): architecture, SONET elements, layers, SONET frames, STS multiplexing, Virtual Tributaries, Alarms topologies, protection architectures, network management.		
Module:2	**WDM optical networks**	**8 hours**
Elements for WDM networks, couplers, splitters, Circulators, Optical multiplexer and demultiplexer, Optical Add-Drop Multiplexer (OADM), Reconfigurable OADM, Optical Cross-Connects (OXC), WDM optical networks, wavelength-routed optical network, routing algorithms.		
Module:3	**Packet switching and access networks**	**10 hours**
Photonic Packet Switching – OTDM, Multiplexing and De-multiplexing, Synchronization, Header Processing, Buffering, Burst Switching, Testbeds Access Technologies-First mile concept; Passive Optical Networks-Fundamental PON architecture; PON Classifications- APON, BPON, EPON and GPON. FTTP Network Design-Link power budget, FTTP-1310-nm Power budget, FTTP-1490-nm Power budget. Link Capacity Estimation-Basic rise time, FTTP link rise time. FTTP Network protection schemes.		
Module:4	**Optical Networking for 5G and Fiber- wireless convergence**	**9 hours**
Challenges associated with the Introduction of 5G; Overview of Fiber-wireless Integrated front-haul systems in 5G. Analog and Digital optical front-haul technologies. Future optical satellite networks, Overview of Visible light, visible light sources, detectors, VLC techniques, current applications. optical communications and sensing for Avionics, current and future flight control systems.		
Module:5	**Artificial Intelligence for Optical Networks**	**9 hours**
AI for Survivable optical networks, Resource allocation, Connection establishment, Network reconfiguration, Failure/fault detection, Statistical solutions for traffic prediction, QoS guarantees and dynamic bandwidth allocation in PONs, Automating network management		

operations, Next generation optical internet, Fiber optic network for IoT applications.

Course Code	Course Title	L	T	P	C
MAEIC608	Quantum Communication	3	0	2	4
Pre-requisite		Syllabus Version			

Module:8	**Contemporary Issues**			**2 hours**
	Total Lecture hours:			**45 hours**
Text Books				
1	R. Ramaswamy, K.N. Sivarajan, Vijay Vusirikala, Optical Networks A practical perspective, 2018, 4th Edition, Morgan Kaufmann, India.			
2	Debasish Datta, Optical Networks, 2021, Oxford University Press, USA.			
Reference Books				
1.	Alan Pak Tao Lau, Faisal Nadeem Khan, Machine Learning for Future Fiber-Optic Communication Systems, 2022, Elsevier Science			
2.	Devi Chadha, Optical WDM Networks From Static to Elastic Networks,2019, Wiley			
Mode of Evaluation: Quiz, Assignment, Design Project, Case Study, Seminar, CAT and FAT				
Mode Evaluation : Continuous Assessment and Final Assessment Test.				
Recommended by Board of Studies				
Approved by Academic Council	**No.**	**Date**		

		1.0
Course Objectives		

1. Provide a strong theoretical foundation in quantum mechanics, quantum states, and quantum operations essential for understanding quantum communication principles.
2. Develop students' ability to apply quantum information theory, quantum algorithms, and quantum error correction techniques for secure and efficient communication systems.
3. Enable students to apply basic concepts in designing and analyzing quantum communication networks and explore emerging quantum technology applications.

Course Outcomes

1. Review principles of quantum mechanics including qubits, superposition, and entanglement
2. Construct quantum circuits to implement protocols for teleportation, superdense coding, and error correction for secure quantum communication.
3. Implement quantum channels, photonic systems, and network architectures to facilitate efficient quantum communication systems.
4. Interpret emerging trends and technologies in quantum communication, quantum internet architectures and quantum-enhanced applications.
5. Analyze quantum communication systems through simulations, focusing on quantum states, circuits, error correction, and channel modeling.

Module:1	**Fundamentals of Quantum Mechanics**	**9 hours**

Review of classical vs quantum systems -Qubits: definition, physical realization – photons, atoms, spins - Quantum states: superposition and basis states - Entanglement: concept, EPR paradox, Bell's inequalities - Quantum measurement and the no-cloning theorem - Visualization: Bloch sphere and state vectors

Module:2	**Basic Quantum Operations and Circuits**	**9 hours**

Quantum gates: Pauli gates, Hadamard, CNOT, phase gates - Quantum circuits: how gates are combined - Unitary operations and reversibility - Simple quantum algorithms: Deutsch-Jozsa, Grover's, Shor's - Quantum parallelism and computational speedup.

Module:3	**Quantum Information Theory**	**9 hours**

Quantum vs. classical information - Quantum entropy, mutual information - Quantum teleportation: principles and step-through - Superdense coding: sending two bits with one qubit - Quantum error correction - Basics of quantum channel capacity

Module:4	**Quantum Communication Systems and Channels**	**9 hours**

Quantum channels: noise models - depolarizing, dephasing, amplitude damping - Photonic qubits and optical quantum communication - Single-photon sources and detectors - Fiber-based and free-space quantum links - Quantum repeaters and long-distance communication challenges - Case study: satellite quantum communication.

Module:5	**Quantum Networks and Emerging Applications**	**7 hours**

Introduction to the quantum internet: architecture, key components - Quantum routing, switching, and network protocols - Quantum cloud computing and remote quantum resources - Emerging applications: quantum-enhanced sensing, quantum metrology - Scalability challenges and future directions

Module:6	**Contemporary Issues**	**2 hours**

Course Code	Course Title	L	T	P	C
MAEIC609	Edge AI for Intelligent Computing	3	0	0	3
Pre-requisite	None	Syllabus Version			
		1.0			
Course Objectives					

	Total Lecture hours: 45 hours
Text Books	
1	M. A. Nielsen and I. L. Chuang, Quantum Computation and Quantum Information, 2021, 10th Anniversary Edition, Cambridge University Press, India
2	Riccardo Manenti and Mario Motta, Quantum Information Science, 2023, Oxford University Press
Reference Books	
1.	R. Van Meter, Quantum Networking, 2022, Wiley, India
2.	Simon Pirandola and Stefano Braunstein, Quantum Communication, 2020, CRC Press
3.	Mark M. Wilde, Quantum Information Theory, 2019, 2nd edition, Cambridge University Press.
Mode of Evaluation: Quiz, Assignment, Design Project, Case Study, Seminar, CAT and FAT	

List of Experiments (Indicative)	
Qubit state preparation and Bloch sphere visualization	**2 hours**
Single-qubit gate operations: Pauli (X, Y, Z), Hadamard, Phase gates	**2 hours**
Entanglement creation (Bell states) and Bell inequality violation simulation	**2 hours**
Projective measurement postulates and no-cloning theorem	**2 hours**
Quantum circuit simulation with unitary operations and reversibility	**2 hours**
Deutsch-Jozsa algorithm simulation	**2 hours**
Grover’s search algorithm simulation	**2 hours**
Measurement probability analysis in quantum circuits	**2 hours**
Quantum teleportation protocol simulation	**2 hours**
Superdense coding implementation	**2 hours**
Quantum entropy and mutual information calculation	**2 hours**
Quantum error correction: simulation of bit-flip and phase-flip codes	**2 hours**
Quantum noise modeling: depolarizing, dephasing, amplitude damping	**2 hours**
Fidelity analysis under noise channels	**2 hours**
QBER simulation and photon loss modeling in optical quantum channels	**2 hours**
Total Laboratory Hours	**30 hours**
Mode of Evaluation: Quiz, Assignment, Design Project, CAT and FAT	

Recommended by Board of Studies			
Approved by Academic Council	**No.**	**Date**	

1. Impart knowledge of intelligent edge computing fundamentals and architectural models, with a focus on the integration of AI, edge hardware and communication interfaces. 2. Assimilate the concepts of machine learning frameworks, AI model suites for edge devices and data visualization for diverse applications. 3. Implement domain-specific applications using edge AI platforms with appropriate security mechanisms to ensure privacy and trust at the edge.			
Course Outcomes			
1. Comprehend the fundamental concepts, architecture of edge computing paradigms and the suitability of various intelligent edge hardware and communication protocols for real-time applications. 2. Apply edge AI and machine learning frameworks for real-time analytics, predictive maintenance, and computer vision applications. 3. Interpret lightweight security mechanisms at the edge to mitigate risk factors and ensure data privacy. 4. Explore various edge AI platforms and their services for developing Edge AI applications, enabling intelligent computing.			
Module:1	**Fundamentals of Edge Computing**		**7 Hours**
Introduction to Computing - Parallel and Distributed Computing, Edge, Fog and Cloud Computing- An overview, Key Benefits of Edge Computing, Edge Computing architecture- Design Parameters, Enabling Technologies, Digital Twin Technology, Edge to cloud Communication, Edge Vs. Cloud Computing.			
Module:2	**Edge Hardware and Communication protocols**		**11 Hours**
Edge Nodes and Actuators, Constraint Devices, IP Gateway Devices, Edge Protocols- BLE**,** RFID**,** Zigbee**, WiFi 6/6E,** Mobile Edge Computing -5G, Edge Accelerators - Offload Computing, Containerization**,** Middleware and Application Interfaces.			
Module:3	**Edge Intelligence**		**11 Hours**
Edge Data Acquisition and Analytics, Machine learning at the Edge – Tools and Framework, Tiny ML and Auto ML Pipelines, Data Visualization through HMI's, Federated Learning, Edge AI Models-CNN and Deep-Q Networks, Computer Vision, Edge AI Software Frameworks and Libraries.			
Module:4	**Edge Security**		**7 Hours**
Privacy concerns in Edge Devices, Edge Data security and Confidentiality- ID based Encryption, Attribute based Encryption, Light weight Cryptographic Solutions, Block chain at the Edge ,Security standards.			
Module:5	**Edge AI Platforms and Use cases**		**7 Hours**
Public Edge Platforms, Edge as a service (EaaS), Edge AI Simulators, Connected and Autonomous Vehicles, Content Delivery, AR/VR, Edge AI for 5G and Beyond Networks, Industrial Internet of Things, Smart Surveillance, Health care, Precision Agriculture, Edge AI for Video Streaming and Processing.			
Module:6	**Contemporary Issues**		**2 hours**
		Total Lecture hours:	**45 hours**
Text Books			
1	Patrick Hung, Hongwei Kan and Greg Knopf ,Edge Computing Acceleration: From 5G to 6G and Beyond, 2024, 1st Edition, Wiley-IEEE Press, United States.		
2	Robert Oshana, Essentials of Edge Computing, 2021,1st Edition, NXP, Netherlands.		

Reference Books	
1.	Xiao Ma , Mengwei Xu , Qing Li , Yuanzhe Li , Ao Zhou and Shangguang Wang, 5G Edge Computing Technologies, Applications and Future Visions, 2024, 1st Edition, Springer Nature, Singapore.
2.	Rajkumar Buyya and Satish Narayana Srirama, Fog and Edge Computing Principles and Paradigms, 2019, 2nd Edition, Wiley, United States.
3.	Sudeep Pasricha and Muhammad Shafique, Embedded Machine Learning for Cyber-Physical, IoT, and Edge Computing: Hardware Architectures,2024, 1st Edition, Springer Nature, Switzerland.
4.	Alex Marcham, Understanding Infrastructure Edge Computing: Concepts, Technologies and Considerations, 2021, 1st Edition, John Wiley & Sons Ltd, United States.
Mode of Evaluation: Quiz, Assignment, CAT and FAT	

Recommended by Board of Studies			
Approved by Academic Council	**No.**	**Date**	

Course Code	**Course Title**	**L**	**T**	**P**	**C**
MAEIC610	**Soft Computing**	**3**	**0**	**0**	**3**
Pre-requisite	**NIL**	**Syllabus Version**			
		1.0			
Course Objectives					

1. Build the fundamentals of soft computing and artificial neural networks. 2. Acquaint the ideas of fuzzy sets, fuzzy logic, and use of Bio-Inspired algorithms. 3. Establish the knowledge on soft computing applications in various fields.		
Course Outcomes		
1. Explore the basics of soft computing and artificial neural network. 2. Compare various multilayer neural network architectures. 3. Comprehend fuzzy decision making and bio-inspired for optimizations in various systems. 4. Explore applications of soft computing in various real-time systems		
Module:1	**Soft Computing and Artificial Neural Network**	**9 hours**
Soft Computing: Introduction to soft computing, soft computing vs. hard computing, various types of soft computing techniques. Artificial Neural Network: Artificial neural networks and their biological motivation, terminology, models of neuron, topology, types of activation functions, learning rules- error correction learning, perceptron – XOR problem– perceptron learning rule – adaline.		
Module:2	**Multilayer Neural Networks**	**9 hours**
Learning paradigms - supervised and unsupervised learning. Multilayer perceptron - back propagation learning algorithm. Associative memory - auto association, hetero association. Recurrent neural networks - Hopfield neural network. Competitive learning neural networks - max net. Kohonen self-organizing feature map.		
Module:3	**Fuzzy logic and Fuzzy inference system**	**9 hours**
Fuzzy Sets: Introduction, fuzzy sets operations, fuzzy relations, fuzzy compositions, membership function. Fuzzy Logic: Fuzzification, fuzzy arithmetic, fuzzy inference system – Mamdani FIS and Sugeno FIS, defuzzification methods.		
Module:4	**Bio-Inspired Algorithms**	**7 hours**
Genetic modeling: Significance of Genetic operators, Inheritance operator, cross over, inversion and deletion, mutation operator, Bitwise operator, GA optimization problems, Applications of GA. Introduction to Particle Swarm Optimization (PSO), Implementation of PSO Algorithm. Artificial Bee Colony Algorithm and applications.		
Module:5	**Applications of Soft Computing**	**9 hours**
Applications of soft computing in Image Processing, Robotics, Mobile Ad hoc Network, Information Retrieval, Medical Diagnosis, Security Systems, and Semantic Web.		
Module:6	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 hours**
Text Books		
1	B. K. Triparty and J. Anuradha, Soft Computing: Advances and Applications, 2015, 1st	

	Edition, Cengage Learning India Private Limited.
2	S. Rajasekaran and G.A. Vijayalakshmi Pai, Neural Networks, Fuzzy Logic and Genetic Algorithm: Synthesis and Applications, 2013, Prentice Hall of India, New Delhi.
Reference Books	
1.	Mohssen Mohammed, Muhammad Badruddin Khan, Eihab Bashier Mohammed Bashi, Machine Learning, Algorithms and Applications, 2016, 1st Edition, CRC Press, Taylor & Francis Group, Boca Raton, Florida, United States
2.	S. N. Sivanandam, S. N. Deepa, Principles of Soft Computing, 2011, 2nd Edition, Wiley, India.
3.	Samir Roy, Udit Chakraborty, Introduction to Soft Computing, 2013, Pearson Education, South Asia.
4.	Alma Y. Alanis, Nancy Arana-Daniel, Carlos Lopez-Franco, Bio-inspired Algorithms for Engineering, 2018, 1st Edition, Butterworth-Heinemann (Elsevier).

Course Code	Course Title	L	T	P	C
MAEIC611	**Blockchain Technology**	**3**	**0**	**0**	**3**
Pre-requisite		**Syllabus Version**			
		1.0			

Course Objectives

1. Provide a conceptual understanding on the function of Blockchain
2. Introduce the Ethereum and solidity platform of Blockchain Technology (BT)
3. Familiarize the current technologies, tools, and implementation strategies of BT

Course Outcomes

1. Outline the concepts of blockchain and decentralized systems.
2. Differentiate different crypto platforms for blockchain
3. Illustrate about smart contracts and applications.

Mode of Evaluation: Quiz, Assignment, Design Project, Case Study, Seminar, CAT and FAT			
Mode Evaluation : Continuous Assessment and Final Assessment Test.			
Recommended by Board of Studies			
Approved by Academic Council	**No.**	**Date**	

4. Apply artificial intelligence technique in various blockchain-enabled communication systems		
Module:1	**Blockchain and Decentralized Systems**	**10 hours**
Introduction to Blockchains, Blockchain Network and mechanism, History of the Blockchain, Characteristics of Blockchains, Block structure, Creation of Blocks and transactions, Dynamic shared ledger, Digital signatures, Hashes as addresses using a key as identity, Architecture of Blockchain- Data Layer, Network Layer and Consensus Layer, Private and Public Blockchains, Blockchain Decentralization, Consensus problem, Merkle Patricia Tree, Abstract Models for Blockchain, Proof of Work (PoW), Proof of Burn, Proof of Stake (PoS) base, Hybrid models (PoW + PoS), Sybil Attack.		
Module:2	**Blockchain Platforms**	**9 hours**
Ethereum – Ethereum Virtual Machine, Wallets for Ethereum, Consensus Mechanism in Ethereum, Identify Ethereum Clients, Bitcoin - Bitcoin protocols, Mining strategy and rewards, Litecoin, Double spending, Hyperledger - Consensus Algorithm in Hyperledger, Hyperledger architecture, Hyperledger and Distributed Ledger Technology, Ledger Implementation, Components of Hyperledger Composer, Benefits of Hyperledger Composer.		
Module:3	**Smart Contracts and Blockchain 3.0**	**9 hours**
Introduction to Smart Contract, Smart contract uses and implementation in real world's applications such as in transportation, land, banking, finance, supply chain management, logistics, etc. Internet of Things based Applications, Medical Record Management System, Domain Name Service and future of Blockchain, Distributed Applications.		
Module:4	**Intelligent Blockchain Technology**	**7 hours**
Blockchain technology and Artificial Intelligence, Machine Learning driven Blockchain Technology, Intelligent Blockchain Technology in Healthcare, Robotic Process Automation		
Module:5	**Blockchain in Communication Systems**	**8 hours**
Cognitive Radio Networks and Blockchain, Blockchain in Wi-Fi and Cellular Networks, Blockchain in 5G Technologies, Blockchain and Cloud Computing, Vehicular Networks, Blockchain enabled IoT Wireless Networks and Smart energy networks.		
Module:6	**Contemporary Issues**	**2 hours**
Future Trends and Challenges - Scalability and interoperability, Quantum computing and blockchain, The future of blockchain regulation and governance		
	Total Lecture hours:	**45 hours**

Text Books	
1	Kumar Sourabh, Ashutosh Saxena, Blockchain Technology - Concepts and Applications, 2020, Wiley
2	Mubashir Husain Rehmani, Blockchain Systems and Communication Networks: From Concepts to Implementation, 2012, Springer.
Reference Books	
1.	Arshdeep Bahga and Vijay K. Madisetti, Blockchain Applications: A Hands-on Approach, 2017, VPT.

2.	Vikram Dhillon, David Metcalf and Max Hooper, Blockchain enabled Applications, 2017, Apress.			
Mode of Evaluation: Quiz, Assignment, Case Study, Seminar, CAT and FAT				
Recommended by Board of Studies				
Approved by Academic Council		**No.**	**Date**	