VIT®

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

(*2023-2024 admitted students*)

VISION STATEMENT OF VELLORE INSTITUTE OF TECHNOLOGY

Transforming life through excellence in education and research.

MISSION STATEMENT OF VELLORE INSTITUTE OF TECHNOLOGY

World class Education: Excellence in education, grounded in ethics and critical thinking, for improvement of life.

Cutting edge Research: An innovation ecosystem to extend knowledge and solve critical problems.

Impactful People: Happy, accountable, caring and effective workforce and students.

Rewarding Co-creations: Active collaboration with national & international industries & universities for productivity and economic development.

Service to Society: Service to the region and world through knowledge and compassion.

VISION STATEMENT OF THE SCHOOL OF ELECTRONICS ENGINEERING

To be a leader by imparting in-depth knowledge in Electronics Engineering, nurturing engineers, technologists and researchers of highest competence, who would engage in sustainable development to cater the global needs of industry and society.

MISSION STATEMENT OF THE SCHOOL OF ELECTRONICS ENGINEERING

- Create and maintain an environment to excel in teaching, learning and applied research in the fields of electronics, communication engineering and allied disciplines which pioneer for sustainable growth.
- Equip our students with necessary knowledge and skills which enable them to be lifelong learners to solve practical problems and to improve the quality of human life.

M. Tech Electronics and Communication Engineering

(Intelligent Communication Systems)

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

1. Graduates will be engineering practitioners and leaders, who would help solve industry's technological problems

2. Graduates will be engineering professionals, innovators or entrepreneurs engaged in technology development, technology deployment, or engineering system implementation in industry

3. Graduates will function in their profession with social awareness and responsibility

4. Graduates will interact with their peers in other disciplines in industry and society and contribute to the economic growth of the country

5. Graduates will be successful in pursuing higher studies in engineering or management

6. Graduates will pursue career paths in teaching or research

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

PROGRAMME OUTCOMES (POs)

PO_01: Having an ability to apply mathematics and science in engineering applications.

PO_03: Having an ability to design a component or a product applying all the relevant standards and with realistic constraints, including public health, safety, culture, society and environment

PO_04: Having an ability to design and conduct experiments, as well as to analyse and interpret data, and synthesis of information

PO_05: Having an ability to use techniques, skills, resources and modern engineering and IT tools necessary for engineering practice

PO_06: Having problem solving ability- to assess social issues (societal, health, safety, legal and cultural) and engineering problems

PO_07: Having adaptive thinking and adaptability in relation to environmental context and sustainable development

PO_08: Having a clear understanding of professional and ethical responsibility

PO_11: Having a good cognitive load management skills related to project management and finance

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

ADDITIONAL PROGRAMME OUTCOMES (APOs)

APO_02: Having Sense-Making Skills of creating unique insights in what is being seen or observed (Higher level thinking skills which cannot be codified)

APO_03: Having design thinking capability

APO_04: Having computational thinking (Ability to translate vast data in to abstract concepts and to understand database reasoning

APO_07: Having critical thinking and innovative skills

APO_08: Having a good digital footprint

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

PROGRAMME SPECIFIC OUTCOMES (PSOs)

On completion of M. Tech Electronics and Communication Engineering (Intelligent Communication Systems) programme, graduates will be able

PSO1: Apply advanced concepts of Communication Engineering to design and develop more efficient next generation communication systems.

PSO2: Use modern technologies in both hardware, software to solve real-world multidisciplinary problems

PSO3: Independently carry out research on diverse communication strategies to address practical problems and present a substantial technical report.

CREDIT INFO		
S.no	**Catagory**	**Credits**
1	Discipline Core	24
2	Discipline Elective	12
3	Projects and Internship	26
4	Open Elective	3
5	Skill Enhancement	5
Total Credits		70

Discipline Core									
sl.no	**Course Code**	**Course Title**	**Course Type**	**Version**	**L**	**T**	**P**	**J**	**Credits**
1	MEIC501L	Machine Learning for Communications	Theory Only	1.0	3	0	0	0	3.0
2	MEIC501P	Machine Learning for Communications Lab	Lab Only	1.0	0	0	2	0	1.0
3	MEIC502L	Communication Networks	Theory Only	1.0	3	0	0	0	3.0
4	MEIC503L	Network Security	Theory Only	1.0	3	0	0	0	3.0
5	MEIC504L	Multimedia Communication Systems	Theory Only	1.0	3	0	0	0	3.0
6	MEIC505L	Internet of Things	Theory Only	1.0	3	0	0	0	3.0
7	MEIC506L	Wireless Communications	Theory Only	1.0	3	0	0	0	3.0
8	MEIC507E	Embedded C Programming	Embedded Theory and Lab	1.0	1	0	4	0	3.0
9	MEIC508P	Communication Technologies Lab	Lab Only	1.0	0	0	4	0	2.0

Discipline Elective									
sl.no	**Course Code**	**Course Title**	**Course Type**	**Version**	**L**	**T**	**P**	**J**	**Credits**
1	MEIC601L	Signal Theory	Theory Only	1.0	3	0	0	0	3.0
2	MEIC602L	Mobile Ad-hoc Networks	Theory Only	1.0	3	0	0	0	3.0
3	MEIC603L	Sensor Networks	Theory Only	1.0	3	0	0	0	3.0
4	MEIC604L	Smart Antennas	Theory Only	1.0	3	0	0	0	3.0
5	MEIC605L	Optical Networks	Theory Only	1.0	3	0	0	0	3.0
6	MEIC607L	Soft Computing	Theory Only	1.0	3	0	0	0	3.0
7	MEIC608L	Blockchain Technology	Theory Only	1.0	3	0	0	0	3.0
8	MEIC609L	Big Data Analytics	Theory Only	1.0	3	0	0	0	3.0

Projects and Internship									
sl.no	**Course Code**	**Course Title**	**Course Type**	**Version**	**L**	**T**	**P**	**J**	**Credits**
1	MEIC696J	Study Oriented Project	Project	1.0	0	0	0	0	2.0
2	MEIC697J	Design Project	Project	1.0	0	0	0	0	2.0

Projects and Internship									
3	MEIC698J	Internship I/ Dissertation I	Project	1.0	0	0	0	0	10.0
4	MEIC699J	Internship II/ Dissertation II	Project	1.0	0	0	0	0	12.0

Open Elective									
sl.no	**Course Code**	**Course Title**	**Course Type**	**Version**	**L**	**T**	**P**	**J**	**Credits**
1	MFRE501L	Francais Fonctionnel	Theory Only	1.0	3	0	0	0	3.0
2	MGER501L	Deutsch fuer Anfaenger	Theory Only	1.0	3	0	0	0	3.0
3	MSTS601L	Advanced Competitive Coding	Soft Skill	1.0	3	0	0	0	3.0

Skill Enhancement									
sl.no	**Course Code**	**Course Title**	**Course Type**	**Version**	**L**	**T**	**P**	**J**	**Credits**
1	MENG501P	Technical Report Writing	Lab Only	1.0	0	0	4	0	2.0
2	MSTS501P	Qualitative Skills Practice	Soft Skill	1.0	0	0	3	0	1.5
3	MSTS502P	Quantitative Skills Practice	Soft Skill	1.0	0	0	3	0	1.5

Course Code	Course Title	L	T	P	C
MEIC501L	Machine Learning for Communications	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. To introduce basic concepts and techniques of machine learning.
2. To understand the different types of regression and data classification.
3. Applying machine learning techniques for communication systems.

Course Outcomes

Students will be able to

1. Comprehend different types of learning, identify data discrepancies and eliminate anomalies.
2. Examine the outcome based on supervised learning and optimization.
3. Interpret the outcome based on unsupervised learning.
4. Design machine learning algorithms for spectrum access and sharing.
5. Analyse supervised learning algorithms, reinforcement algorithms for Adaptive Modulation and Coding schemes.
6. Apply machine learning techniques for traffic prediction and interference management in cellular networks.

Module:1	Fundamentals of machine learning	8 hours

Revision of probability theory and random process, linear algebra, Introduction to machine learning: supervised/unsupervised/reinforcement learning, Data preprocessing: Data cleaning, Integration, Transformation and Reduction, Performance measure.

Module:2	Regression and Classification	6 hours

Linear multi linear regression(MLR), Logistic model estimation evaluation, Radial basis function (RBF), Support vector machine (SVM), Support vector regression (SVR)- Random forest (RF), Bayes' theorem-Parameter estimation distribution - Classifier networks K-nearest neighbors.

Module:3	Clustering	6 hours

Introduction, Mixture densities, Types of partitioning, Hierarchical supervised learning after Clustering - Choosing number of clusters, Applications.

Module:4	Reinforcement Learning and Optimization	6 hours

Introduction to RL, Immediate RL, Bandit algorithm, Optimization, Derivative-based, Derivative-free.

Module:5	Machine Learning for Spectrum Access and Sharing	5 hours

Online learning algorithms for opportunistic spectrum access, Performance measures of the online learning algorithms, Random and deterministic approaches, Adaptive sequencing rules approach, Structure of transmission epochs, Learning algorithms for channel allocation, Distributed learning.

Module:6	Machine Learning–Based Adaptive Modulation and Coding Design	6 hours

Introduction and Motivation, Supervised Learning, Assisted AMC (KNN, SVM, RF)

Module:7	Machine learning for mobile network design	6 hours

User grouping/clustering in D2D, HetNets for offloading, Traffic prediction and interference management in HetNets, Clustering of small cells in HetNets to avoid interference in CoMP.		
Module:8	**Contemporary Issues**	**2 hours**
Guest Lecture from Industries and R & D Organizations.		
	Total Lecture hours:	**45 hours**
Text Book(s)		
1.	Kevin P. Murphy, Machine Learning: A Probabilistic Perspective, 2020, 2nd Edition, MIT Press.	
2.	Fa-long Luo, Machine Learning for future Wireless Communication, 202, 1st Edition, Wiley-IEEE Press.	
Reference Books		
1.	Alpaydin Ethem, Introduction to Machine Learning, 2019, 3rd Edition, PHI learning private limited.	
Mode of Evaluation: Continuous Assessment Test, Digital Assignment, Quiz and Final Assessment Test		

Recommended by Board of Studies	07-06-2023		
Approved by Academic Council	No. 70	Date	24-06-2023

Course Code	Course Title	L	T	P	C
MEIC501P	Machine Learning for Communications Lab	0	0	2	1
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. To implement the machine learning algorithms.
2. To understand the practical applications of machine learning algorithms.
3. To apply the machine learning algorithms in communication systems.

Course Outcomes

Students will be able to

1. Examine the unsupervised and supervised machine learning techniques.
2. Analyse the machine learning Algorithms in advanced communication systems.

Indicative Experiments

1.	Performance analysis of supervise and unsupervised learning.	4 hours
2.	Performance analysis of linear regression and radial basis function with classifiers.	4 hours
3.	Performance analysis of clustering based hierarchical supervised learning.	4 hours
4.	Performance analysis of machine learning based adaptive modulation and coding schemes.	4 hours
5.	Performance comparison of cognitive radio and machine learning based cognitive radio.	6 hours
6.	Traffic analysis in machine learning based wireless networks.	4 hours
7.	Machine learning based Interference management scheme in HetNet.	4 hours
	Total Laboratory Hours	**30 hours**

Mode of assessment: Continuous assessment / FAT / Oral examination and others

Recommended by Board of Studies	07-06-2023		
Approved by Academic Council	No. 70	Date	24-06-2023

Course Code	Course Title	L	T	P	C
MEIC502L	Communication Networks	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. To explain the fundamental concepts of different open systems interconnection layers of network protocol stack and provide an understanding on the factors that influence the network performance.
2. To introduce the students to various protocols and standards suitable for communication networks.
3. To familiarize the students to various high-speed and intelligent networks.

Course Outcomes

Students will be able to

1. Demonstrate network evolution, network architecture and the functions of the OSI, TCP/IP reference models.
2. Interpret the reliable data transfer protocols.
3. Analyze network layer routing protocols and learn about SDN.
4. Examine the transport layer protocols, with an emphasis on congestion control
5. Analyze the different queuing models.
6. Illustrate the performance of various high-speed networks and learn about intelligent networks.

Module:1	Applications and Layered Architectures	5 hours

OSI Reference Model, TCP/IP Architectures, Application Protocols and TCP/IP Utilities, Addressing, Network Performance metrics.

Module:2	Data Link Layer Protocols	8 hours

ARQ Protocols, Error Control in Peer to Peer protocols, MAC Protocols-Contention based MAC Protocol- Channel polling based MAC protocol, Scheduling based MAC Protocol, Hybrid MAC Protocols.

Module:3	Network Layer Protocols	8 hours

Internet Protocol- IPv4, IPv6, ICMP,ARP,RARP,IGMP,SNMP, Unicast Routing protocols, Multicast Routing protocols- Software Defined Networking

Module:4	Congestion control Protocols	8 hours

Transport layer protocols - Transmission Control Protocol- User Datagram Protocol- Stream Control Transmission Protocol – Effects of congestion - congestion control mechanisms, Behaviour of TCP, UDP over WLAN-Challenges and solutions for TCP over wireless.

Module:5	Queuing Models	5 hours

Arrival Processes, Queuing System classifications, M/M/1 queuing model-steady state probabilities-effect of scale on performance, M/G/1 model- Priority queuing systems.

Module:6	High Speed Networks	5 hours

Packet switching networks, High speed LAN, Ethernet, WLAN, VLAN, VPN, and Enterprise Network.

Module:7	Intelligent Networks	4 hours

Intelligent Wireless Networks- Case Studies- Design Challenges and Open Issues.

Module:8	**Contemporary Issues**	**2 hours**
Guest Lecture from Industries and R & D Organizations		
	Total Lecture hours:	**45 hours**

Text Book(s)	
1.	Leon Gracia, Widjaja, Communication Networks, 2017, 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.	James Kurose and Keith Ross, Computer Networking: A Top-Down Approach Featuring the Internet, 2017, 7th Edition, Pearson Education.
2	W. Stallings, Data and Computer Communications, 2017, 10th Edition, Pearson Prentice Hall, USA.
3	Jerry FitzGerald, Alan Dennis, Alexandra Durcikova, Business Data Communications and Networking, 2021, 14th Edition, ISBN: 978-1-119-70284-9, Wiley.

Mode of Evaluation: Continuous Assessment Test, Digital Assignment, Quiz and Final Assessment Test			
Recommended by Board of Studies	07-06-2023		
Approved by Academic Council	No. 70	Date	24-06-2023

Course Code	Course Title	L	T	P	C
MEIC503L	Network Security	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. To introduce the security mechanism and various encryption techniques.
2. To impart knowledge on message confidentiality, integrity and availability using cryptography.
3. To explain the different types of networks and cyber security with AI and its significance.

Course Outcomes

Students will be able to

1. Comprehend the various mathematical techniques in cryptography, including number theory, finite Field, modulo operator, elliptic curve arithmetic and discrete logarithm.
2. Analyze modern block and stream ciphers, data encryption standard (DES), advanced encryption standard (AES), IDEA and key exchange algorithms.
3. Classify asymmetric ciphers: RSA, ElGamal, RABIN cryptosystem.
4. Interpret the various types of data integrity and authentication schemes.
5. Realize user authentication methods along with various key distribution algorithms.
6. Examine the various network security mechanism and usage of AI in cyber security.

Module:1	Mathematical Foundations for Cryptography	7 hours

Introduction to cryptography, Number theory and finite fields (Group, Ring and Fields), Fermat's and Euler's Theorems, Chinese remainder theorem, Fast exponentiation, Discrete logarithms, Elliptic curve arithmetic, and principles of pseudorandom number generation.

Module:2	Symmetric Ciphers	7 hours

Modern block ciphers and modern stream ciphers- DES, AES, IDEA pseudorandom number generation based on symmetric cipher, Key exchange algorithm: Diffie-Hellman key exchange.

Module:3	Asymmetric Ciphers	7 hours

RSA cryptosystem, RABIN cryptosystem, ElGamal cryptosystem, Elliptic curve cryptography, simulating Elgamal, Pseudorandom number generation based on an asymmetric cipher.

Module:4	Data Integrity Algorithms	6 hours

Cryptographic hash functions: MD4, SHA-512, Whirlpool; Message authentication codes; Digital signatures: RSA, Elgamal, Schnorr, DSS.

Module:5	Mutual trust	5 hours

Key management and distribution, X.509, Quantum key distribution (QKD), User authentication protocols, Kerberos.

Module:6	Network and Internet Security	6 hours

Firewalls, Transport level security: SSL, TLS, IEEE 802.11, 11i : Wireless LAN security, WAP, Electronic mail security, IP Security: IKE.

Module:7	AI in Cybersecurity	5 hours

Security in machine learning (ML) systems, Spam detection using ML, Malware

detection and analysis using ML, bot detection using ML, Identifying unexpected intruders or breaches using ML, Anomaly detection in user behavior, Intrusion detection using ML.		
Module:8	**Contemporary Issues**	**2 hours**
Guest Lecture from Industries and R & D Organizations		
	Total Lecture hours:	**45 hours**
Text Book(s)		
1.	William Stallings, Cryptography and Network security: Principles and Practice, 8th Edition, 2020, Pearson Education, India.	
Reference Books		
1.	Atul Kahate, Cryptography And Network Security, 2019, 4th Edition, The McGraw Hill Company.	
2	Behrouz A.Forouzan, Debdeep Mukhopadhyay, Cryptography & Network Security, 3rd edition, 2015, The McGraw Hill Company.	
3	Carrasco-Casado, Alberto & Marmol, Veronica & Denisenko, Natalia, Free-Space Quantum Key Distribution" 2016, 10.1007/978-3-319-30201-0_27.	
4	Clarence Chio & David Freeman, Machine Learning and Security, 2018, O'Reilly publication.	
Mode of Evaluation: Continuous Assessment Test, Digital Assignment, Quiz and Final Assessment Test		
Recommended by Board of Studies	07-06-2023	
Approved by Academic Council	No. 70	Date 24-06-2023

Course Code	Course Title	L	T	P	C
MEIC504L	Multimedia Communication Systems	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. To introduce fundamental concepts and data compression algorithms for multimedia systems.
2. To familiarize the students with the network services and protocols for multimedia communication.
3. To understand multimedia information sharing through communication systems.

Course Outcomes

Students will be able to

1. Understand basics of multimedia communication systems.
2. Classify the different data and multimedia compression mechanism.
3. Analyze network services and protocols for multimedia communication.
4. Interpret internet multimedia content distribution.
5. Describe the information-sharing systems over wireless mobile networks.
6. Relate the necessity of cloud computing for multimedia services and social media sharing.

Module:1	Fundamental of Multimedia	5 hours

Introduction to Multimedia, Fundamental concepts in video- analog video and digital video, Basics of audio, Digitization of sound, MIDI: Musical instrument digital interface, Quantization and transmission of audio.

Module:2	Basics Data Compression Algorithms	5 hours

Lossless compression algorithms: Basics of information theory, Run-length coding, Shannon–Fano algorithm, Huffman coding, Arithmetic coding, Lossless image compression, Differential coding of images, Lossless JPEG.

Lossy compression algorithms: Quantization, Uniform and scalar quantization, Nonuniform scalar quantization, Vector quantization, Discrete cosine transform, Wavelet-based coding.

Module:3	Multimedia Data Compression	7 hours

Image compression Standards: JPEG Standard, JPEG2000 Standard, JPEG-LS Standard

Video Compression Techniques: Introduction to video compression, Video compression based on motion compensation, Search for motion vectors, MPEG-1, MPEG-2, MPEG-4, MPEG-7.

Module:4	Network Services and Protocols for Multimedia Communications	7 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

Module:5	Internet Multimedia Content Distribution	6 hours

Proxy caching, Content distribution networks (CDNs), Broadcast/Multicast video-on-demand, Broadcast/Multicast for heterogeneous users, Application-Layer

Multicast, peer-to-peer video streaming with mesh overlays, HTTP-Based Media Streaming.		
Module:6	**Multimedia Over Wireless and Mobile Networks**	**6 hours**
Characteristics of wireless channels, Wireless networking technologies, Multimedia over wireless channels, Error detection, Error correction, Error-resilient coding, Error concealment, Mobility management, Network layer Mobile IP, Link-layer handoff management		
Module:7	**Multimedia Information Sharing**	**7 hours**
Social media sharing: Representative social media services, User-Generated media content sharing, Media propagation in online social networks **Cloud Computing for Multimedia Services**: Cloud Computing Overview, Multimedia Cloud Computing, Cloud-Assisted Media Sharing, Computation Offloading for Multimedia Services		
Module:8	**Contemporary Issues**	**2 hours**
Guest Lecture from Industries and R & D Organizations		
	Total Lecture hours:	**45 hours**

Text Book(s)	
1.	Z.N. Li, M.S. Drew, J. Liu, Fundamentals of multimedia, 2021, 3rd edition, Springer, Cham Heidelberg, New York, Dordrecht, London
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.	K.R. Rao, Z.S., Bojkovic, B.M. Bakmaz, Wireless Multimedia Communication Systems: Design, Analysis, and Implementation, 2014, 1st Edition, CRC Press, Taylor & Francis Group, Boca Raton, Florida, United States

Mode of Evaluation: Continuous Assessment Test, Digital Assignment, Quiz and Final Assessment Test			
Recommended by Board of Studies	07-06-2023		
Approved by Academic Council	No. 70	Date	24-06-2023

Course Code	Course Title	L	T	P	C
MEIC505L	Internet of Things	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. To introduce the architecture of Internet of Things (IoT) and its communication and networking protocols.
2. To impart the knowledge on various IoT platforms and security and privacy aspects in IoT.
3. To familiarize the concepts of data mining and machine learning algorithms.

Course Outcomes

Students will be able to

1. Understand the basic building blocks, architecture and applications of IoT.
2. Analyze different communication protocols and its significance.
3. Examine various networking protocols used for IoT.
4. Envision the hardware and software platforms used for IoT.
5. Interpret the various security and privacy issues related to IoT systems and their mitigation techniques.
6. Analyze commonly used data mining processes and analytics techniques used for IoT.

Module:1	Internet of Things and Architecture	5 hours

IoT Definition and ecosystem, Wireless Ad-hoc and Sensor Networks, Layered Architecture for IoT (Three layered and five layered architecture), Case studies: Smart Cities, Smart Grids, Industrial IoT, Agriculture, Healthcare.

Module:2	Communication Protocol	6 hours

Protocol Architecture of IoT, MAC protocols for sensor network, S-MAC, IEEE 802.15.4, Near field communication (NFC), RFID, ZigBee, Bluetooth low energy (BLE), IPv6 over Low-Power Wireless Personal Area Networks (6LoWPAN), Cellular Connectivity – 4G and 5G, LoRa and LoRaWAN, Sigfox.

Module:3	Networking Protocol	6 hours

Constrained application protocol (CoAP), Message queue telemetry transport (MQTT), Extensible messaging and presence protocol (XMPP), Advanced message queuing protocol (AMQP), Data distribution service (DDS), Service discovery protocols, Routing protocol for low power and lossy networks (RPL), Sensor networks and their architecture, Advantages of ad-hoc/sensor network.

Module:4	Platforms: Hardware, Software and Cloud	7 hours

Sensors, Actuators, MCUs: Arduino, Raspberry-pi, Intel Galileo, Sensor Data Gateway, The IoT Data Analytics Platforms: IBM Watson IoT Platform, Splunk Software for IoT Data, Amazon Web Service IoT Platform, Azure IoT Hub, The IoT Data Virtualization Platforms, IoT Data Visualization and Analytics Platform.

Module:5	IoT Security and Privacy	6 hours

Security issues and mechanisms, Traditional vs Lightweight security, Technologies and methods that mitigate security, Privacy issues, standards and regulations.

Module:6	Data Mining and Preprocessing	6 hours

Introduction to data mining, Applications of data mining, Need of Need for Data Pre-processing and exploratory data analysis, Measures of center and spread, Outliers and detection, Data normalization, Data transformation.		
Module:7	**Machine Learning Techniques used in IoT**	**7 hours**
Machine learning: what and why? Types of ML techniques, Supervised learning: Linear Regression, Logistic Regression, Classification: SVM, K-Nearest Neighbour (KNN), Decision Trees, Unsupervised learning: K Mean Clustering, Hierarchical Clustering, Agglomerative Clustering, Case studies: Smart cities and Agriculture		
Module:8	**Contemporary Issues:**	**2 hours**
Guest Lecture from Industries and R & D Organizations		
	Total Lecture hours:	**45 hours**

Text Book(s)

1.	Picone, M., Cirani, S., Ferrari, G., Veltri, L. Internet of Things: Architectures, Protocols and Standards, 2018, Wiley, United Kingdom.

Reference Books

1.	Pethuru Raj and Anupama C. Raman, The Internet of Things: Enabling Technologies, Platforms, and Use Cases, 2017, CRC Press.
2.	Lea, P., Internet of Things for Architects: Architecting IoT Solutions by Implementing Sensors, Communication Infrastructure, Edge Computing, Analytics, and Security", 2018, Packt Publishing, India.
3.	Milenkovic, M, "Internet of Things: Concepts and System Design" 2020, Springer International Publishing, Germany.
4.	Mohamed, K. S. The Era of Internet of Things: Towards a Smart World, 2019, Springer International Publishing, Germany.
5.	Kapoor A, Hands-On-Artificial Intelligence for IoT: Expert machine learning and deep learning techniques for developing smarter IoT systems, 2019, Packet Publishing Ltd.
6.	Raul R, Kautish S, Polkowski Z, Kumar A and Liu C M (Eds), Green Internet of Things and Machine Learning: Towards a Smart Sustainable World, 2022, John and Wiley Sons.

Mode of Evaluation: Continuous Assessment Test, Digital Assignment, Quiz and Final Assessment Test

Recommended by Board of Studies	07-06-2023		
Approved by Academic Council	No. 70	Date	24-06-2023

Course Code	Course Title	L	T	P	C
MEIC506L	Wireless Communications	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. To understand the different technologies in wireless communication systems.
2. To analyze the concepts of physical layer transmission techniques.
3. To Design and infer on next-generation wireless communication systems.

Course Outcomes

Students will be able to

1. Describe the evolution of different wireless communication systems and standards.
2. Analyze the mobile radio propagation, fading, and the channel modeling.
3. Interpret code division multiple-access techniques for wireless communications.
4. Apply the power and rate control methods in OFDM and OTFS.
5. Analyze the modern multi-antenna communication systems.
6. Explain the future wireless communications technologies.

Module:1	Evolution of Wireless Communications	4 hours

Introduction to wireless communications, Evolution of modern wireless communication systems- 2G/3G/4G/5G, Types of services, Requirement for the services, Spectrum limitations, Noise and interference limited systems, Multiple access schemes.

Module:2	Wireless Propagation Channels	6 hours

Large scale propagation-Propagation effects, Reflection, Diffraction and scattering, Free space propagation model, Two-ray ground reflection model, Log-distance path loss model, Log-normal shadowing, Outdoor propagation models, Okumura model, Hata model, COST-231, 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	Code-Division Multiple Access	6 hours

Introduction to CDMA, Mechanism, Spreading codes, Multi-user CDMA, Advantages of CDMA, CDMA forward and reverse channels, Soft handoff, CDMA features, Power control, Performance analysis of CDMA system.

Module:4	OFDM and OTFS	8 hours

Principle of orthogonal frequency division multiplexing (OFDM) - Implementation of transceivers, Cyclic prefix, Peak-to-Average Power Ratio (PAPR), Inter carrier interference, BER analysis of OFDM, Orthogonal time frequency spreading (OTFS), Signal representation, Implementation as overlay, Diversity and channel gain.

Module:5	Massive MIMO	8 hours

MIMO system model, MIMO Configurations - SISO, SIMO, MISO, MIMO, Diversity combining techniques, Selection combining (SC), Maximal Ratio Combining (MRC) and Switch-and-Stay Combining (SSC), Diversity gain, MIMO receivers – Zero-Forcing (ZF), Minimum Mean Square Error (MMSE), Coding techniques -Alamouti,

STBC, Beamforming techniques, Spatial Multiplexing, Multi-user MIMO-advantages and challenges, receivers, Massive MIMO- Channel model, Channel hardening, Matched filter receiver, Pilot contamination.		
Module:6	**Key Wireless Communication Technologies**	**6 hours**
Cooperative communications-Fundamentals of Relaying, Relaying with Multiple and Parallel Relays, Applications. Device-to-Device Communications - Advanced Interference Processing, Non-orthogonal multiple access (NOMA)-Power domain, Code domain, Interference alignment, Radio wave propagation for mmWave - Large-scale and Small-scale propagation channel effects, Applications of mmWave Communications.		
Module:7	**5G and B5G –New Radio**	**5 hours**
5G System Overview - Physical Layer, Logical channels, Procedures - Carrier Aggregation and License-Assisted Access, Coordinated multipoint (CoMP), Dual Connectivity, and HetNet Support, Beyond 5G applications, Network Design, Spectrum Usage, Physical and MAC Layer Aspects, Real-Time Processing and RF Transceiver Design.		
Module:8	**Contemporary Issues**	**2 hours**
Guest Lecture from Industries and R & D Organizations		
	Total Lecture hours:	**45 hours**

Text Book(s)	
1.	Andreas F. Molisch, Wireless Communications: From Fundamentals to Beyond 5G, 2022, 3rd Edition, Wiley-IEEE Press. USA ISBN: 978-1-119-11720-9.
2.	Feng Ouyang, Digital Communication for Practicing Engineers, 2019. 1st Edition, Wiley-IEEE Press, USA, ISBN: 978-1-119-41800-9.
Reference Books	
1.	Suvra Sekhar Das, Ramjee Prasad. OTFS: orthogonal time frequency space modulation a waveform for 6G, 2021, River Publishers, Denmark, ISBN: 978-8770226561.
2.	Emil Björnson, Jakob Hoydis and Luca Sanguinetti, Massive MIMO Networks: Spectral, Energy, and Hardware Efficiency, 2017, Foundations and Trends® in Signal Processing, Now publishers, Netherlands, ISBN: 978-1-68083-985-2.
3.	Theodore S. Rappaport, Robert W. Heath, Robert C. Daniels, James N. Murdock, Millimeter Wave Wireless Communications, 2021, 1st edition, Pearson, UK, ISBN-13: 9780132172288.
4.	John W. Leis, Communication Systems Principles Using MATLAB, 2018, 1st Ed., Wiley-IEEE Press, USA, ISBN: 978-1-119-47067-0.

Mode of Evaluation: Continuous Assessment Test, Digital Assignment, Quiz, Final Assessment Test			
Recommended by Board of Studies	07-06-2023		
Approved by Academic Council	No. 70	Date	24-06-2023

Course Code	Course Title	L	T	P	C
MEIC507E	Embedded C Programming	1	0	4	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. To impart logical thinking and fundamental problem-solving skills via the use of a programming language.
2. To develop basic and advanced programming concepts using C and Embedded C language.
3. To interface with microcontroller using Embedded C language.

Course Outcomes

Students will be able to

1. Apply the C programming language for various problem-solving applications.
2. Analyze embedded C programming for various embedded applications.

Module:1	C Programming	2 hours

Introduction to Embedded C, Difference between C & Embedded C. Introduction to C programming, comments, identifiers, variables, headers, data types, operators, order of operations, format specifies, escape sequence characters, input and output statements, programs on sequential statements.

Module:2	Control and Loop statements	2 hours

Control statements: If, If-else, If-else ladder, elif ladder, Switch. Loops: Do-While, While, For loops and nested loops. Break, Continue, goto and exit statements. Programs on If, Switch and loops.

Module:3	Arrays & Strings	2 hours

Arrays: one dimensional and multi-dimensional array, programs on Arrays. Strings, Functions, Pointers, Structures & Unions.

Module:4	8051 Microcontroller	2 hours

Introduction to microcontroller different Microcontroller (vs) Microprocessor, external interface of the standard 8051, Reset requirements, Clock frequency and performance memory issues, I/O pins, Timers, Interrupts, Serial interface, Power consumption.

Module:5	Embedded C	2 hours

Modular programming-Multiple file programs, Extern and static declaration (for variable and for functions)-how executable file are created-the compiler-the linker-project structure- Object libraries-Advanced use of Pointers-void pointers, pointers to functions-Pointers to structures.

Module:6	Programming Embedded Systems in C	2 hours

Embedded world, Reading switches, Adding Structure to the code, object oriented programming with C, Meeting real time constraints, using the serial interface.

Module:7	Interfacing with displays	2 hours

Programming of LED's Interfacing, Interfacing Circuit Description of 7 Segment Display, Programming of 7 Segment Display Interfacing, Interfacing Circuit Description of 16 x 2 LCD Programming of 16 x 2 LCD.

Module:8	**Contemporary Issues**	**1 hours**
Guest Lecture from Industries and R & D Organizations		
	Total Lecture hours:	**15 hours**

Text Book(s)	
1	Stephen Oualline, Bare Metal C: Embedded Programming for the Real World Paperback, 2022, 1st Edition, William Pollock, San Francisco.
2	Mike McGrath, C Programming in easy steps, 2019, 5th Edition, In Easy Steps Limited.

Lab Component :		
Indicative Experiments		
1	C program to evaluate each of the liner/numerical/differential equations using loops and if conditions.	10 hours
2	C program to do expensive operations on switching and strings.	10 hours
3	C program to do the operations on multidimensional arrays (searching, sorting, traversing, inserting, deleting, updating, multiplication, addition and subtraction)	10 hours
4	C program using nested user-defined functions and structures.	10 hours
5	Embedded C Programming of 7 Segment display and 16 x 2 LCD.	10 hours
6	Embedded C Programming of Interfacing circuit description 7 Segment display and 16 x 2 LCD.	10 hours
	Total Laboratory Hours	**60 hours**

Mode of assessment: Continuous assessment and FAT			
Recommended by Board of Studies	07-06-2023		
Approved by Academic Council	No. 70	Date	24-06-2023

Course Code	Course Title	L	T	P	C
MEIC508P	Communication Technologies Lab	0	0	4	2
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. To introduce the concept of digital data transmission through wired/wireless channels.
2. To familiarize the student with concept of spread spectrum and multicarrier communications.
3. To acquaint with the opportunities and challenges of recent communication technologies.

Course Outcomes

Students will be able to

1. Develop transceiver to examine the end-to-end system performance.
2. Build the transceiver in Universal Software Radio Peripheral (USRP) to transmit receive the given text and image.
3. Apply physical layer signal processing and RF techniques to enhance the performance of 5G and beyond networks/Wi-Fi 7.

Indicative Experiments		
1.	Probability of error analysis of digital modulation techniques	8 hours
2.	Transceiver design of spread spectrum and multi-carrier communications	8 hours
3.	Text and image transmission using USRP	8 hours
4.	Probability of error analysis of MIMO configurations system	10 hours
5.	Generation of waveforms and end-to-end link level simulation of IEEE 802.11be (Wi-Fi 7)	8 hours
6.	Generation of 3GPP defined 5G NR reference waveforms, channel sounding and beamforming	10 hours
7	Design of Phased array antenna using CST Microwave Studio	8 hours
	Total Laboratory Hours	**60 hours**

Text Book(s)

1. John G. Proakis, Masoud Salehi, Digital Communication, 2018, 5th Edition (Indian edition), Mc Graw Hill Education, India.
2. Andreas F. Molisch, Wireless Communications: From Fundamentals to Beyond 5G, 2022, 3rd Edition, Wiley-IEEE Press. USA ISBN: 978-1-119-11720-9.

Reference Books

1. John W. Leis, Communication Systems Principles Using MATLAB, 2018, 1st Edition, Wiley-IEEE Press, USA, ISBN: 978-1-119-47067-0.
2. Feng Ouyang, Digital Communication for Practicing Engineers, 2019. 1st Edition, Wiley-IEEE Press, USA, ISBN: 978-1-119-41800-9.

Mode of assessment: Periodic Assessment Test/ FAT

Recommended by Board of Studies	07-06-2023		
Approved by Academic Council	No. 70	Date	24-06-2023

Course Code	Course Title	L	T	P	C
MEIC601L	Signal Theory	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. To introduce to students the concepts of deterministic signals and systems as well as random signals.
2. To make the students understand the concepts of linear signal models and optimum linear filters.
3. To make the students comprehend the concepts of least squares and adaptive filters.

Course Outcomes

Students will be able to

1. Understand deterministic and random signals and process them through linear systems.
2. Represent the signals as AR, MA and ARMA models.
3. Analyze optimum FIR and IIR filters.
4. Develop recursive algorithms and implement structures for optimum linear filters.
5. Analyze filters based on linear least squares method.
6. Analyze LMS and RLS adaptive filters.

Module:1	Discrete time signals	5 Hours

Discrete time signals, Transform domain representation of deterministic signals, Discrete-time systems, Minimum phase and system invertibility.

Module:2	Random variables, vectors and sequences	6 Hours

Random variables, Random vectors, Discrete time stochastic processes, Linear systems with stationary random inputs, Innovation representation of random vectors.

Module:3	Linear Signal Models	5 Hours

Linear Nonparametric and Parametric Signal models, All-pole models, All-zero models, Pole-zero models, Models with poles on the unit circle

Module:4	Optimum Linear Filters	8 Hours

Optimum signal estimation, Linear 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:5	Algorithms and Structures for optimum linear filters	8 Hours

Fundamentals of order, recursive algorithms, Interpretation of algorithmic quantities, Order-recursive algorithms for optimum FIR filters, Algorithms Levinson and Levinson - Durbin

Module:6	**Least-Squares filtering and prediction**	**6 Hours**
The principles of Least squares, Linear least square estimation, Least-square FIR filters, Linear least square signal estimation, LS computation using the normal equations, LS computation using Orthogonalization techniques, LS computation using singular value decomposition		
Module:7	**Adaptive Filters**	**5 Hours**
Principles of adaptive filters, Method of steepest decent, LMS adaptive filters, RLS adaptive filters, Fast RLS algorithms for FIR filtering		
Module:8	**Contemporary Issues**	**2 Hours**
Guest Lecture from Industries and R & D Organizations		
	Total Lecture hours:	**45 Hours**

Text Book(s)	
1.	Anastasia Veloni, Nikolaos Miridakis, Erysso Boukouvala, Digital and Statistical Signal Processing, 2020, 1st Edition, CRC Press, Boca Raton.
2	Papoulis.A and Pillai S.U, "Probability, Random Variables and Stochastic Processes, 2017, 4th Edition, McGraw Hill Education.
Reference Books	
1.	Hayes.M.H, Statistical Digital Signal Processing and Modeling, 2008, John Wiley &Sons, Inc
2	Malonakis.D.G, Ingle.V.K and Kogon.S.M, Statistical and Adaptive Signal Processing, 2000, McGraw-Hill.

Mode of Evaluation: Continuous Assessment Test, Digital Assignment, Quiz and Final Assessment Test			
Recommended by Board of Studies	07-06-2023		
Approved by Academic Council	No. 70	Date	24-06-2023

Course Code	Course Title	L	T	P	C
MEIC602L	Mobile Ad- hoc Networks	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives:

1. To acquaint the fundamentals of ad hoc wireless networks and cellular networks.
2. To design contention-based MAC protocols and routing protocols for ad hoc networks.
3. To recognize the QoS frameworks, network security issues, energy management and paraphrase the mobile adhoc network towards WSN, VANET, FANET and UAV.

Course Outcomes:

Students will be able to

1. Interpret the deployment considerations and challenges in adhoc network.
2. Classify the contention-based MAC protocols based on reservation and scheduling mechanism.
3. Interpret the unicast and multicast routing protocols.
4. Examine the network security solution and routing mechanism.
5. Recognize the QoS solutions, security issue and energy management in ad hoc networks.
6. Analyze the architecture and data processing of wireless sensor network.

Module:1	Cellular and Ad hoc Wireless Networks	6 hours

Introduction to Cellular and Ad hoc wireless networks, Applications of ad hoc networks, Issues in ad hoc wireless networks, Medium access scheme, Routing, Multicasting, Transport layer protocols, Pricing scheme, Quality of Service provisioning, Self-organization, Security, Address and security discovery, Energy management, Scalability, Deployment considerations, Ad hoc wireless Internet.

Module:2	MAC Protocols	8 hours

Issues in designing a MAC Protocol for ad hoc wireless networks, design goals of a MAC Protocol for Ad hoc wireless networks, Classification of MAC Protocols, Contention based Protocols, Contention based Protocols with Reservation mechanism, Contention Based MAC Protocols with Scheduling Mechanisms, Other MAC protocols

Module:3	Routing Protocols	10 hour

Design issues and classification, Table-driven, On-demand and Hybrid routing protocols, Routing protocols with efficient flooding mechanisms, Hierarchical and Power-aware routing protocol - Multicast routing protocols- Classification, Tree-based and Mesh-based protocols, Energy-Efficient multicasting.

Module:4	Network Security	6 hours

Network security Requirements -Issues and challenges, Network security attacks, Key management, Secure routing protocols

Module:5	Quality of Service and Security Issues	4 hours

Issues and challenges in providing QoS, Classification of QoS solutions, MAC layer solutions, Network layer solutions, QoS frameworks, Network security issues

Module:6	Energy Management Systems	4 hours

Classifications and need for battery management schemes, Transmission power management schemes, System power management schemes.

Module:7	**Trending ad hoc Networks**	**5 hours**
Wireless Sensor Networks: Architecture, Data dissemination, Data gathering, MAC Protocols, Location discovery, Quality of a sensor network, Issues and current trends in MANETs, VANETs, WSN, 6LoWPAN, FANETs, UAV networks: UAV and UAV networks, challenges in deployment of UAV networks.		
Module:8	**Contemporary Issues**	**2 hours**
Guest Lecture from Industries and R & D Organizations		
	Total lecture hours:	**45 hours**

Text Book(s)	
1.	C. Siva Ram Murthy, B. S. Manoj, Ad-Hoc Wireless Networks: Architectures and Protocols, 2014, 1st Edition, Prentice Hall, New Jersey.
Reference Books	
1.	C. K. Toh, AdHoc Mobile Wireless Networks: Protocols and Systems, 2016, 1st Edition, Pearson Education, South Asia.
2.	Mohammad Ilyas, The Handbook of AdHoc Wireless Networks, 2017, 1st Edition, CRC press, Florida.
3.	Holger Karl, Andreas Willig, Protocols and Architectures for Wireless Sensor Networks, 2017, 1st Edition, Wiley, New York.
4.	G Ram Mohana Reddy, Kiran M, Mobile Ad Hoc Networks: Bio-Inspired Quality of Service Aware Routing Protocols, 2020, 1st Edition, CRC Press, Taylor & Francis Group, Boca Raton, Florida, United States

Mode of evaluation: Internal Assessment (CAT, Quizzes, Digital Assignments) & Final Assessment Test (FAT)

Recommended by Board of Studies	07-06-2023		
Approved by Academic Council	No. 70	Date	24-06-2023

Course Code	Course Title	L	T	P	C
MEIC603L	Sensor Networks	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives:

1. To comprehend the fundamentals of wireless sensor networks and its significance in real-time applications.
2. To learn the features of different wireless sensor networks and standards.
3. To study the design, performance and challenges in Wireless Sensor Networks.

Course Outcomes:

Student will be able to

1. Understand WSN architecture and its protocol stack.
2. Understand the Physical layer standard and MAC layer protocols.
3. Analyze various Routing protocols in WSN.
4. Analyze the various Transport layer, Application layer protocols.
5. Interpret the application layer and cross-layer interactions in WSN.
6. Analyze various localization techniques and performance models used in WSN.

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 standards -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**	**6 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.		
Module:5	**Application Layer and Cross layer solutions**	**6 hours**
Source coding, Query Processing, Network management, Interlayer effects, Cross layer interactions.		
Module:6	**Localization in WSN**	**5 hours**
Challenges in localization, Ranging techniques, Range-based localization, Range-free localization.		
Module:7	**Performance and Traffic Management**	**3 hours**
Performance Modeling of WSNs, Case Study: Simple Computation of the System Life Span.		
Module:8	**Contemporary Issues**	**2 hours**
Guest Lecture from Industries and R & D Organizations		
	Total lecture hours:	**45 hours**

Text Book(s)	
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.
3.	Holger Karl, Andreas Wiilig, Protocols and Architectures for Wireless Sensor Networks, 2011, 1st Edition, John Wiley & Sons Ltd.
2.	Anna Hac, Wireless Sensor Network Designs, 2013, 1st Edition, John Wiley & Sons Ltd.
4.	Anna Forster, Introduction to Wireless Sensor Networks, 2016, 1st Edition, John Wiley & Sons Ltd.
Mode of Evaluation: Internal Assessment (CAT, Quizzes, Digital Assignments) & Final Assessment Test (FAT)	
Mode of evaluation: Continuous Assessment & Final Assessment Test (FAT).	
Recommended by Board of Studies	07-06-2023
Approved by Academic Council	No. 70 / Date / 24-06-2023

Course Code	Course Title	L	T	P	C
MEIC604L	Smart Antennas	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

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.

Course Outcomes

Students will be able to

1. Understand the performances of switched beam, adaptive antenna systems and Multiple access schemes.
2. Explain the Smart antenna transmitter and receiver architecture.
3. Analyze the direction of arrival estimation for smart antenna systems.
4. Interpret the environmental parameters for signal processing of Smart antenna systems.
5. Design and implementation of smart antenna systems
6. Analyze the smart antenna protocols and space-time processing

Module:1	Smart Antennas and Multiple access schemes	5 hours

Introduction, Need for smart antennas, Smart antenna configurations, Switched-Beam antennas, Adaptive antenna approach, Multiple access schemes: SDMA, FDMA, TDMA, CDMA, and OFDMA.

Module:2	Smart Antenna Architecture	6 hours

Architecture of a Smart antenna system, Receiver, Transmitter, Pros and cons, Basic principles, Multiple input multiple outputs (MIMO), MIMO-Relay system models, Mutual coupling effects.

Module:3	Direction-of-Arrival Estimation	7 hours

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.

Module:4	Beamforming Techniques	7 hours

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.

Module:5	Integration and Simulation of Smart Antennas	6 hours

Overview, Antenna design, Mutual coupling, Adaptive signal processing algorithms, DOA, Adaptive beam forming, Types of fading, Beamforming and diversity Combining: Rayleigh, Rician and Nakagami fading.

Module:6	Smart antenna Networks and protocols	6 hours

Trellis-Coded Modulation (TCM) for Adaptive Arrays, Smart antenna systems for Mobile Ad hoc Networks (MANETs), Protocol, Simulations.

Module:7	Space–Time Processing	6 hours

Introduction, Discrete space–time channel and Signal models, Space– time beam forming, Inter symbol and Co-channel suppression, Space –time processing for DS-CDMA, Capacity and data rates in MIMO Systems.		
Module:8	**Contemporary Issues**	**2 hours**
Guest Lecture from Industries and R & D Organizations.		
	Total Lecture hours:	**45 hours**

Text Book(s)	
1.	Constantine A. Balanis & Panayiotis I. Ioannides, Introduction to Smart Antennas, 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
Reference Books	
1.	Praveen Kumar Malik, Joan Lu, B.T.P. Madhav, Geeta Kalkhambkar, Swetha Amit, Smart Antennas: Latest Trends in Design and Application, 2022, Springer Nature, Switzerland.
2.	Frank Gross, Smart Antennas with MATLAB, 2015, McGraw-Hill Professional.

Mode of Evaluation: Continuous Assessment Test, Digital Assignment, Quiz and Final Assessment Test			
Recommended by Board of Studies	07-06-2023		
Approved by Academic Council	No. 70	Date	24-06-2023

Course Code	Course Title	L	T	P	C
MEIC605L	Optical Networks	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives:

1. To introduce the basic concepts of optical networking, network architectures, topologies and generations.
2. To familiarize various optical access networks, optical wireless networks and optical network in 5G.
3. To explore artificial intelligence in optical communication and networks.

Course Outcomes:

Students will be able to

1. Describe the different generations of optical networks and its classes.
2. Interpret the different network architectures, topologies and multi-channel systems.
3. Explain the WDM components and routing algorithms.
4. Analyze the different optical access network technologies and their network design.
5. Interpret an optical wireless communication system and its significance in 5G.
6. Apply artificial intelligence algorithms in optical networks.

Module:1	Overview of Optical Networking	4 hours

Introduction to optical networking, Evolution of optical networking - Major Technological milestones: First and second generation optical Networks. Classes of optical networks.

Module:2	Network Architectures, Topologies and Multi-Channel Systems	6 hours

End-to-End transmission path loss and dispersion budgets in network designing, Optical signal flow and constraints, Design of star, bus, mesh and ring topologies, Multiplexing and multiple access schemes: TWDM/MA, Sub-carriers, CDMA, Capacity allocation for dedicated connections, Demand assigned connections.

Module:3	WDM optical networks	6 hours

Elements for WDM networks, Optical MUX and DEMUX, Optical add-drop multiplexer (OADM), Reconfigurable OADM, Optical cross-connects (OXC), power couplers, power splitters, WDM optical networks, wavelength-routed optical network, routing algorithms.

Module:4	Optical Access networks	7 hours

Access Technologies-First mile concept, Passive Optical networks (PON) - 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:5	Optical wireless network	7 hours

Introduction to free space optical communication (FSO), Transmitter and Receiver selection criteria for FSO, Optical system design for FSO, Link margin analysis with optical loss, Geometrical loss, Pointing loss, Atmospheric loss and receiver sensitivity, Factors affecting FSO -Transmission of IR Signals through the Atmosphere, Impact of weather, Line-Of-Sight (LOS), other factors affecting FSO, selecting the transmission wavelength, Integration of FSO in optical networks.

Module:6	**Optical Networking for 5G and Fiber wireless convergence**	**7 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, Optical communications and sensing for Avionics, Current and future flight control systems.		
Module:7	**Artificial intelligence for optical systems**	**6 hours**
Machine learning (ML) for long-haul and short-reach optical fiber systems, ML techniques for passive optical networks. End-to-End learning for fiber-optics communication systems, Deep learning techniques for optical monitoring-building blocks of deep learning-based optical monitors, ML methods for Quality-of Transmission estimation.		
Module:8	**Contemporary Issues**	**2 hours**
Guest Lecture from Industries and R & D Organizations		
	Total lecture hours:	**45 hours**

Text Book(s)	
1.	R. Ramaswami, K.N. Sivarajan, Vijay Vusirikala, Optical Networks A practical perspective, 2018, 4th Edition, Morgan Kaufmann, India.
2.	Biswanath Mukherjee, Ioannis Tomkos, Massimo Tornatore, Peter Winzer, Yongli Zhao, Springer Handbook of Optical Networks, 2020, Springer International Publishing, Switzerland.
3.	Alan Pak Tao Lau , Faisal Nadeem Khan,Machine Learning for Future Fiber-Optic Communication Systems, 2022, Elsevier Science
Reference Books	
1.	Partha Pratim Sahu, Fundamentals of Optical Networks and Components, 2020, CRC Press, India.
2.	Debasish Datta, Optical Networks, 2021, Oxford University Press, USA.
3.	Partha Pratim Sahu, Advances in Optical Networks and Components, 2020, CRC Press.
4.	A. Arockia Bazil Raj, Arun K. Majumdar, Zabih Ghassemlooy , Principles and Applications of Free Space Optical Communications, 2019 , Institution of Engineering & Technology.
5.	Devi Chadha, Optical WDM Networks From Static to Elastic Networks, 2019, Wiley.

Mode of evaluation: Internal Assessment (CAT, Quizzes, Digital Assignments) & Final Assessment Test (FAT)

Recommended by Board of Studies	07-06-2023		
Approved by Academic Council	No. 70	Date	24-06-2023

Course Code	Course Title	L	T	P	C
MEIC607L	Soft Computing	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. To understand the fundamentals of soft computing, artificial neural network and its applications.
2. To observe the fundamentals of fuzzy logic and genetic algorithm.
3. To develop the notion about CNN and RNN.

Course Outcomes

Students will be able to

1. Understand the basics of soft computing and artificial neural network.
2. Comprehend fuzzy sets and relations in various systems.
3. Acquaint with fuzzy decision-making and genetic algorithm.
4. Comprehend bio-inspired and evolutionary algorithms.
5. Recognize the characteristics of Deep learning models to solve real-world problems.
6. Interpret the applications of soft computing.

Module:1	Soft Computing and Artificial Neural Network	7 hours

Soft Computing: Introduction, Evolutionary Computing, Hard Computing Vs. Soft Computing, Soft Computing Methods, Artificial Neural Network: Model of Biological Neuron, Mathematical Model of Neuron, ANN Architecture, Learning Rules, Learning Paradigms, Perceptron Network, Adaline and Madaline Networks.

Module:2	Fuzzy Sets and Relations	7 hours

Fuzzy Sets: Basic Concepts, Paradigm Shift, Representations, Alpha-cuts, Basic Operations: Properties, Complements, Intersections and Unions, Intuitionistic, Alpha–Beta Cuts, Relations: Binary, Intuitionistic.

Module:3	Fuzzy Logic, Ruled Based Systems and Decision Making	7 hours

Fuzzy Logic: Logic, Interval Analysis, Fuzzy Numbers, Fuzzy Logic, Fuzzy ruled based systems: Linguistic Variables and Linguistic Hedges, Rule-Based Systems, Fuzzy Propositions, Fuzzification and defuzzification, Fuzzy Decision Making: Individual, Multiperson, Multicriteria, Multistage.

Module:4	Genetic Algorithm	6 Hours

Genetic modeling: Significance of Genetic operators, Inheritance operator, cross over, inversion and deletion, mutation operator, Bitwise operator, GA optimization problems, Job Shop Scheduling Problem (JSP), Travelling Salesman Problem (TSP), Differences and similarities between GA and other traditional methods, Applications of GA.

Module:5	Bio-Inspired and Evolutionary Algorithms	6 hours

Introduction to Particle swarm optimization (PSO), Implementation of PSO, PSO Algorithm, Variants of PSO: Binary, Adaptive, Multi-objective, Hybrid Model, Artificial Bee Colony Algorithm, Micro artificial Bee colony algorithm, Bacterial foraging optimization algorithm.

Module:6	Deep learning	6 hours

Convolutional Neural Networks: Kernel and feature map, Sparse connectivity, equivariance through parameter sharing, pooling function for invariant representation, convolution and pooling as strong prior, Convolution with stride, Effect of zero padding, single-channel and multi-channel data types used in ConvNet. **Recurrent Neural Networks**: Sequence learning with neural nets, unrolling the recurrence, training RNN - Back propagation through time (BPTT), vanishing gradient problem.		
Module:7	**Applications of Soft Computing Techniques**	**4 hours**
Pattern Recognition, Image Processing, Soft Computing in Mobile Ad hoc Network, Soft Computing in Information Retrieval and Semantic Web.		
Module:8	**Contemporary Issues**	**2 hours**
Guest lecture from Industries and R & D Organizations		
	Total Lecture hours:	**45 hours**

Text Book(s)	
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).
5.	Bengio, Yoshua, Ian J. Goodfellow, and Aaron Courville. "Deep learning" 2015, MIT Press

Mode of Evaluation: Continuous Assessment Test, Digital Assignment, Quiz and Final Assessment Test			
Recommended by Board of Studies	07-06-2023		
Approved by Academic Council	No. 70	Date	24-06-2023

Course Code	Course Title	L	T	P	C
MEIC608L	Blockchain Technology	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. To provide a conceptual understanding of the function of Blockchain.
2. To introduce the Ethereum and solidity platform.
3. Develop familiarity of current technologies, tools and implementation strategies.

Course Outcomes

Students will be able to

1. Analyze the decentralization and cryptographic concepts.
2. Determine different crypto transactions in the blockchain.
3. Examine smart contracts and applications.
4. Apply artificial intelligence techniques in blockchain.
5. Design and implement blockchains for various applications in communication systems.

Module:1	Blockchains	6 hours

Introduction to blockchain, Blockchain network and mechanism, History of the blockchain, The benefits of Blockchains, Block structure, Creation of blocks and transactions, Dynamic shared ledger, Digital signatures, How to build a Blockchain solution, Hashes as addresses using a key as identity, Global blockchain ecosystem Core, Layers of a Blockchain- Data layer, network layer, consensus layer, Private and Public Blockchains.

Module:2	Distributed Consensus	6 hours

Consensus problem, Merkle Patricia Tree, Abstract Models for Blockchain, GARAY model, RLA Model, Proof of Work (PoW), Proof of Burn, Proof of Stake (PoS) base, Hybrid models (PoW + PoS), Sybil Attack.

Module:3	Ethereum	6 hours

Ethereum Virtual Machine, Wallets for Ethereum, Smart Contracts, Attacks on Smart Contracts, Consensus Mechanism in Ethereum, Identify Ethereum Clients, Platform Functions, Solidity, Solidity Operators and Functions, structuring a contract, Comparing Wei and Ether, gas transaction.

Module:4	Cryptocurrencies and Hyperledger	8 hours

History, Introduction to Bitcoin, Bitcoin protocols - Mining strategy and rewards, Litecoin, Double spending, Ethereum-Construction, Ripple, Monero, DAO, GHOST, Vulnerability, Attacks, Sidechain, Namecoin. Hyperledger Consensus Algorithm, Hyperledger architecture, Hyperledger and Distributed Ledger Technology, Hyperledger Fabric Developer Environment Tools, Ledger Implementation, Components of Hyperledger Composer, Benefits of Hyperledger Composer.

Module:5	Smart Contracts and Blockchain Applications	7 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 (Blockchain 3.0)

Module:6	Intelligent Blockchain Technology	5 hours

Blockchain technology and Artificial Intelligence, Machine Learning driven Blockchain Technology, Intelligent Blockchain Technology in Healthcare, Robotic Process Automation.		
Module:7	**Blockchain in Communication Systems**	**5 hours**
Blockchain in 5G Technologies, Blockchain in FoG and Cloud Computing, Vehicular Networks, Blockchain enabled IoT Wireless Networks, Cognitive Radio Networks and Blockchain.		
Module:8	**Contemporary Issues**	**2 hours**
Guest Lecture from Industries and R & D Organizations		
	Total Lecture hours:	**45 hours**
Text Book(s)		
1.	Arshdeep Bahga and Vijay K. Madisetti, Blockchain Applications: A Hands-on Approach, 2017, VPT.	
2.	Mubashir Husain Rehmani, Blockchain Systems and Communication Networks: From Concepts to Implementation, 2012, Springer.	
Reference Books		
1.	Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller and Steven Goldfeder, Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction, 2016, Princeton University Press.	
2.	Kumar Sourabh, Ashutosh Saxena, Blockchain Technology - Concepts and Applications, 2020, Wiley.	
3.	Vikram Dhillon, David Metcalf and Max Hooper, Blockchain enabled Applications, 2017, A press.	
4.	Roger Wattenhofer, Blockchain Science: Distributed Ledger Technology, 2019, 3rd Edition, Inverted Forest Publishing.	
Mode of Evaluation: Continuous Assessment Test, Digital Assignment, Quiz and Final Assessment Test		

Recommended by Board of Studies	07-06-2023		
Approved by Academic Council	No. 70	Date	24-06-2023

Course Code	Course Title	L	T	P	C
MEIC609L	Big Data Analytics	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. To understand the need for Big Data and different analytical architectures.
2. To analyze the analytical life cycle using statistical models, regression and model planning.
3. To apply data analytic techniques in medical healthcare and communication systems.

Course Outcomes

Students will be able to

1. Recognize the characteristics of big data and its life cycles for efficient handling.
2. Analyse the various statistical models for data analytics.
3. Illustrate the importance of machine learning algorithms in data analytics.
4. Interpret the data analytics use cases and models using linear and logistic regressions.
5. Relate data analytics processes in the healthcare system.
6. Apply data analytics to communication systems.

Module:1	Introduction to Big Data	6 hours

Big date overview: Data Structures, Analyst Perspective on Data Repositories. State of practice in analytics, Big Data Enabling Technologies, Role of Data Scientists, Examples of Big Data Analytics, Data Analytics Lifecycle

Module:2	Data Analytics Lifecycle	6 hours

Overview of Data Analytics Lifecycle, Key Roles for a Successful Analytics Project. Different phases: Discovery, Data Preparation, Model Planning, Model Building, Communicate Results, Operationalize.

Module:3	Statistical Methods for Data Analytics	7 hours

R Graphical User Interfaces, Data Import and Export, Attribute and Data Types, Descriptive Statistics, Visualizing a Single and multiple Variable, Hypothesis Testing, Difference of Means, Wilcoxon Rank-Sum Test, Type I and Type II Errors, Power and Sample Size.

Module:4	Data Analytics and Machine Learning	6 hours

Machine Learning Basics, Supervised Machine Learning Algorithms: Taxonomy of Machine Learning Algorithms, Bayesian Network and Ensemble Methods, Unsupervised Machine Learning Algorithms: Clustering Methods without Labels, Dimensionality Reduction Algorithms

Module:5	Advanced Analytical Theory and Methods: Regression	6 hours

Linear Regression: Use Cases, Model Description, Diagnostics. Logistic Regression, Reasons to Choose and Cautions, Additional Regression Models. Analytics for Unstructured Data, The Hadoop Ecosystem,

Module:6	Big Data Analytics for Health-Care and Cognitive Learning	6 hours

Healthcare Problems and Machine Learning Tools, IoT-based Healthcare Systems and Applications, Big Data Analytics for Healthcare Applications, Emotion-Control Healthcare Applications

Module:7	Big Data Applications in the Telecommunications Industry	6 hours

Predicting 4G Adoption with Apache Spark: A Field Experiment, Mining of Leaders in Mobile Telecom Social Networks, Network-Based Targeting: Big Data Application in Mobile Industry				
Module:8	**Contemporary Issues**			**2 hours**
Guest Lecture from Industries and R & D Organizations				
	Total Lecture hours:			**45 hours**
Text Book(s)				
1.	Dietrich, D., Heller, B. and Yang, B., Data science & big data analytics: discovering, analyzing, visualizing and presenting data, 2015, Wiley.			
2	Sedkaoui, S., Data analytics and big data, 2018, John Wiley & Sons.			
Reference Books				
1.	Hwang, K. and Chen, M., Big-data analytics for cloud, IoT and cognitive computing, 2017, John Wiley & Sons.			
2.	Minelli, M., Chambers, M. and Dhiraj, A., Big data, big analytics: emerging business intelligence and analytic trends for today's businesses, 2013, John Wiley & Sons.			
3.	Ye Ouyang, and Mantian Hu, Big Data Applications in the Telecommunications Industry, 2017, IGI Global, DOI: 10.4018/978-1-5225-1750-4.			
Mode of Evaluation: Continuous Assessment Test, Digital Assignment, Quiz and Final Assessment Test				
Recommended by Board of Studies	07-06-2023			
Approved by Academic Council	No. 70	Date	24-06-2023	

Course Code	Course Title	L	T	P	C
MEIC696J	Study Oriented Project				02
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives:

1. The student will be able to analyse and interpret published literature for information pertaining to niche areas.
2. Scrutinize technical literature and arrive at conclusions.
3. Use insight and creativity for a better understanding of the domain of interest.

Course Outcomes:

1. Retrieve, analyse, and interpret published literature/books providing information related to niche areas/focused domains.
2. Examine technical literature, resolve ambiguity, and develop conclusions.
3. Synthesize knowledge and use insight and creativity to better understand the domain of interest.
4. Publish the findings in the peer reviewed journals / National / International Conferences.

Module Content	(Project duration: One Semester)

This is oriented towards reading published literature or books related to niche areas or focussed domains under the guidance of a faculty.

Mode of Evaluation: Evaluation involves periodic reviews by the faculty with whom the student has registered. Assessment on the project – Report to be submitted, presentation and project reviews – Presentation in the National / International Conference on Science, Engineering Technology.

Recommended by Board of Studies	07.11.2023		
Approved by Academic Council	No.	Date	

Course Code	Course Title	L	T	P	C
MEIC697J	Design Project				02
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives:

1. Students will be able to design a prototype or process or experiments.
2. Describe and demonstrate the techniques and skills necessary for the project.
3. Acquire knowledge and better understanding of design systems.

Course Outcomes:

1. Develop new skills and demonstrate the ability to upgrade a prototype to a design prototype or working model or process or experiments.
2. Utilize the techniques, skills, and modern tools necessary for the project.
3. Synthesize knowledge and use insight and creativity to better understand and improve design systems.
4. Publish the findings in the peer reviewed journals / National / International Conferences.

Module Content **(Project duration: One Semester)**

Students are expected to develop new skills and demonstrate the ability to develop prototypes to design prototype or working models related to an engineering product or a process.

Mode of Evaluation: Evaluation involves periodic reviews by the faculty with whom the student has registered. Assessment on the project – Report to be submitted, presentation and project reviews – Presentation in the National / International Conference on Science, Engineering Technology.

Recommended by Board of Studies	07.11.2023		
Approved by Academic Council	No.	Date	

Course Code	Course Title	L	T	P	C
MEIC698J	Internship I/ Dissertation I				10
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives:

To provide sufficient hands-on learning experience related to the design, development and analysis of suitable product / process so as to enhance the technical skill sets in the chosen field and also to give research orientation.

Course Outcomes:

1. Considerably more in-depth knowledge of the major subject/field of study, including deeper insight into current research and development work.
2. The capability to use a holistic view to critically, independently and creatively identify, formulate and deal with complex issues.
3. A consciousness of the ethical aspects of research and development work.
4. Publications in the peer reviewed journals / International Conferences will be an added advantage.

Module Content **(Project duration: One Semester)**

1. Dissertation may be a theoretical analysis, modeling & simulation, experimentation & analysis, prototype design, fabrication of new equipment, correlation and analysis of data, software development, applied research and any other related activities.
2. Dissertation should be individual work.
3. Carried out inside or outside the university, in any relevant industry or research institution.
4. Publications in the peer reviewed journals / International Conferences will be an added advantage.

Mode of Evaluation: Assessment on the project - Dissertation report to be submitted, presentation, project reviews and Final Oral Viva Examination.

Recommended by Board of Studies	07.11.2023		
Approved by Academic Council	No.	Date	

Course Code	Course Title	L	T	P	C
MEIC699J	Internship II/ Dissertation II				12
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives:

To provide sufficient hands-on learning experience related to the design, development and analysis of suitable product / process so as to enhance the technical skill sets in the chosen field.

Course Outcomes:

Upon successful completion of this course students will be able to

1. Formulate specific problem statements for ill-defined real life problems with reasonable assumptions and constraints.
2. Perform literature search and / or patent search in the area of interest.
3. Conduct experiments / Design and Analysis / solution iterations and document the results.
4. Perform error analysis / benchmarking / costing.
5. Synthesize the results and arrive at scientific conclusions / products / solution.
6. Document the results in the form of technical report / presentation.

Module Content **(Project duration: One Semester)**

1. Dissertation may be a theoretical analysis, modeling & simulation, experimentation & analysis, prototype design, fabrication of new equipment, correlation and analysis of data, software development, applied research and any other related activities.
2. Dissertation should be individual work.
3. Carried out inside or outside the university, in any relevant industry or research institution.
4. Publications in the peer reviewed journals / International Conferences will be an added advantage.

Mode of Evaluation: Assessment on the project - Dissertation report to be submitted, presentation, project reviews and Final Oral Viva Examination.

Recommended by Board of Studies	07.11.2023		
Approved by Academic Council	No.	Date	

Course code	Course Title	L	T	P	C
MFRE501L	Français Fonctionnel	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. Demonstrate competence in reading, writing, and speaking basic French, including knowledge of vocabulary (related to profession, emotions, food, workplace, sports/hobbies, classroom and family).
2. Achieve proficiency in French culture oriented view point.

Course Outcome

At the end of the course, the student will be able to

1. Remember the daily life communicative situations via personal pronouns, emphatic pronouns, salutations, negations, interrogations etc.
2. Create communicative skill effectively in French language via regular / irregular verbs.
3. Demonstrate comprehension of the spoken / written language in translating simple sentences.
4. Understand and demonstrate the comprehension of some particular new range of unseen written materials.
5. Demonstrate a clear understanding of the French culture through the language studied.

Module:1	**Saluer, Se présenter, Etablir des contacts. Compétences en lecture - consulter un dictionnaire, appliquer des stratégies de lecture, lire pour comprendre.**	**9 hours**

Les nombres cardinaux- Les 7 jours de la semaine-Les 12 mois de l'année- La date-Les saisons-Les Pronoms personnels sujets-Les Pronoms Toniques- La conjugaison des verbes réguliers- er / - ir /-re verbes (Le présent)- La conjugaison des verbes irréguliers- avoir /être / aller / venir / faire /vouloir /pouvoir etc.

Savoir-faire pour: saluer, et se présenter – épeler en français – communiquer en classe – utiliser des stratégies pour comprendre un texte en français.

Module:2	**Présenter quelqu'un, Chercher un(e) correspondant(e), Demander des nouvelles d'une personne.**	**7 hours**

La conjugaison des verbes Pronominaux (s'appeler/ s'amuser/ se promener)- La Négation- L'interrogation avec 'Est-ce que ou sans Est-ce que'- Répondez négativement.

Module:3	**Situer un objet ou un lieu, Poser des questions**	**6 hours**

Les articles (défini/ indéfini)- Les prépositions (à/en/au/aux/sur/dans/avec etc.)- L'article contracté- L'heure- La Nationalité du Pays- Les professions- L'adjectif (La Couleur, l'adjectif possessif, l'adjectif démonstratif, l'adjectif interrogatif (quel/quelle/quels/quelles)- L'interrogation avec Comment/ Combien / Où etc., Pronoms relatifs simples (qui/que/dont/où).

Module:4	**Comprendre et traduire un texte court, Demander et indiquer le chemin.**	**5 hours**

La traduction simple d'un texte/ dialogue :(français-anglais / anglais –français)

Module:5	**Trouver les questions, Répondre aux questions générales en français, Écouter des vidéos (site internet, YouTube) qui aident à améliorer leur prononciation/ vocabulaire et leurs compétences orales**	**6 hours**

L'article Partitif (du/ de la / de l'/ des) -Faites une phrase avec les mots donnés- Mettez les phrases en ordre, masculin/féminin ; singulier/pluriel- Associez les phrases- les adverbes de temps (ensuite/hier/puis….)

Module:6	**Comment écrire un passage - développer des ompétences rédactionnelles. Discussion de groupe (donnez un sujet et demandez aux élèves de partager**	**5 hours**

	leurs idées)	
Décrivez La Famille -La Maison -L'université -Les Loisirs-La Vie quotidienne- La ville natale- Un personnage célèbre		
Module:7	**Comment écrire un dialogue**	**5 hours**
Dialogue a) Réserver un billet de train b) Entre deux amis qui se rencontrent au café c) Parmi les membres de la famille d) Entre le patient et le médecin e) Entre le professeur et l'étudiant(e)		
Module:8	**Contemporary Topics**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)	
1.	Adomania 1, Méthode de français, CelineHimber, Corina Brillant, Sophie Erlich. Publisher HACHETTE, February 2016.
2.	Enchanté 1 !, Méthode de français, Rachana Sagar Private Limited, Jan 2017.
Reference Books	
1.	Le français pour vous 1, Méthode de français, VinodSikri, Anna Gabriel Koshy, Prozopublishing, Jan 2019.
2.	Accueil 1, Méthode de français, Rachana Sagar Private Limited, January 2016
3.	Apprenons le français 1 Méthode de français, Mahitha Ranjit & Monica Singh, Jan 2019
Modeof Evaluation **:** Continuous Assessment Tests, Quizzes, Assignment, Final Assessment Test	

Recommended by Board of Studies	19-05-2022		
Approved by Academic Council	No. 66	Date	16-06-2022

Course code	Course Title	L	T	P	C
MGER501L	Deutsch für Anfänger	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. Demonstrate competency in reading, writing and speaking in Basic German.
2. Achieve proficiency in German culture oriented view point.
3. Develop basic vocabulary in the technical field.

Course Outcome

At the end of the course, the student will be able to

1. Communicate in German language in their daily life communicative situations.
2. Apply the German language skill in writing corresponding letters, E-Mailsetc.
3. Create the talent of translating passages from English-German and vice versa and to
   frame simple **dialogues** based on given situations.
4. Understand and demonstrate the comprehension of some particular new range of unseen
   written materials.
5. Develop a general understanding of German culture and society.

Module:1	Die erste Begegnung	6 hours

Einleitung, Begrüssungs formen, Länder und Sprachen, Alphabet, Buchstabieren, Personalpronomen, Zahlen (1-100), Telefonnummer und E-Mail Addressenennen W-fragen, Aussagesätze, Nomen – Singular und Plural und Artikel

Lernziel:

Verständnisvon Deutsch, Genus- Artikelwörter

Module:2	Hobbys und Berufe	6 hours

Über Hobbyssprechen, Wochentage, Jahreszeiten, und Monatenennen, Uhrzeitensagen, über Arbeit, Berufe und Arbeitszeitensprechen, Zahlen (Hundertbiseine Million) Aritel (bestimmter, unbestimmter), Plural der Substantive, Konjugation der Verben (regelmässig /unregelmässig), Ja-/Nein- Frage, Imperativmit Sie.

Lernziel :

Sätzeschreiben, überHobbyserzählen, über Berufesprechenusw.

Module:3	Alltag und Familie	7 hours

Über die Familiesprechen, eineWohnungbeschreiben, Tagesablaufschreiben, Mahlzeiten, Lebensmittel, Getränke Possessivpronomen, Negation, Kasus- Akkusativ und Dativ (bestimmter, unbestimmterArtikel), trennnbareverben, Modalverben, Adjektive, Präpositionen

Lernziel :

Sätzemit Modalverben, Verwendung von Artikel, über Familiesprechen, eine Wohnungbeschreiben.

Module:4	Situations gespräche	6 hours

Dialoge:

a) Gespräche mit Familienmitgliedern, am Bahnhof,
b) Gespräche beim Einkaufen, in einem Supermarkt, in einer Buchhandlung
c) Gespräche in einem Hotel/ in einem Restaurant, Treffen im Cáfe, Termin beim Arzt.

Module:5	Korrespondenz	6 hours

Leseverständnis, Mindmapmachen, Korrespondenz- Briefe, Postkarten, E-Mail

Lernziel :

Wortschatzbildung und aktiverSprachgebrauch

Module:6	Aufsatzschreiben	6 hours

Aufsätze :

Meine Universität, Das Essen, mein Freund odermeine Freundin, meine Familie, einFest in Deutschlandusw.

Module:7	Übersetzungen	6 hours

Übersetzungen : (Deutsch – Englisch / Englisch –Deutsch)

Lernziel :

Grammatik – Wortschatz – Übung		
Module:8	**Trainierung den Sprachfähigkeiten**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)	
1.	Netzwerk A1, Stefanie Dengler, Paul Rusch, Helen Schmitz, Tanja Sieber, Ernst Klett Sprachen GmbH, Stuttgart, 2017
Reference Books	
1.	Studio d A1 Deutsch als Fremdsprache, Hermann Funk, Christina Kuhn, Silke Demme: Heuber Verlag, Muenchen, 2012.
2.	Lagune ,Hartmut Aufderstrasse, Jutta Müller, Thomas Storz,. Muenchen, 2012
3.	Deutsche SprachlehrefürAusländer, Heinz Griesbach, Dora Schulz, 2011, Berlin
4.	Themen Aktuell 1, Hartmurt Aufderstrasse, Heiko Bock, MechthildGerdes, Jutta Müller und Helmut Müller, 2010, Muenchen.
	www.goethe.de wirtschaftsdeutsch.de hueber.de, klett-sprachen.de www.deutschtraning.org

Mode of Evaluation **:** Continuous Assessment Tests, Quizzes, Assignment, Final Assessment Test			
Recommended by Board of Studies	19-05-2022		
Approved by Academic Council	No.66	Date	16-06-2022

Course Code	Course Title	L	T	P	C
MSTS601L	Advanced Competitive Coding	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. To understand the basic concepts of data structures and algorithm.
2. To develop the step by step approach in solving problems with the help programming techniques of data structures.
3. To deploy algorithms in real time applications.

Course Outcomes

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

1. Provide a basic understanding of core Java concepts
2. Use linear and non-linear data structures to solve practical problems.
3. Identify Bitwise algorithms for solving real world problems.
4. Illustrate various techniques for searching, sorting and hashing
5. Understand and implement Dynamic Programming.
6. Design new algorithms or modify existing algorithms for new application.

Module:1	Algorithms	6 hours

Java Introduction, Features, Structure, Data Types, Basic I/O Operators, Decision making and Control structure, Time & Space complexity

Module:2	Math based problems and Bitwise algorithms	6 hours

Simple Sieve, Segmented & Incremental Sieve, Euler's phi Algorithm, Strobogrammatic Number, Remainder Theorem, Toggle the switch & Alice Apple tree, Binary Palindrome, Booth's Algorithm, Euclid's Algorithm, Karatsuba Algorithm, Longest Sequence of 1 after flipping a bit Swap two nibbles in a byte.

Module:3	Arrays , Searching, Sorting and Strings	6 hours

Block Swap Algorithm , Max product subarray, Maximum sum of hour glass in matrix ,Max Equilibrium Sum ,Leaders in array, Majority element, Lexicographically first palindromic string, Natural Sort order , Weightes substring ,Move hyphen to beginning, Manacher's Algorithm

Module:4	Recursion, Back tracking, Greedy Algorithm	6 hours

Sorted Unique Permutation, Maneuvering, Combination, Josephus trap, Maze Solving, N Queens Problem, Warnsdorff's Algorithm, Hamiltonian Cycle, Kruskal's Algorithm ,Activity Selection Problem, Graph Coloring, Huffman Coding

Module:5	Dynamic Programming	6 hours

Longest Common Subsequence ,Longest Increasing Subsequence , Longest Bitonic Subsequence ,Longest Palindromic Subsequence ,Subset sum problem ,0-1 Knapsack, Traveling Salesman, Coin Change, Shortest Common, Supersequence, Levenshtein Distance problem, Rod Cutting problem, Wildcard pattern matching , Pots of gold game

Module:6	Linked list, Stack, Queue	6 hours

Loop Detection, Sort the bitonic DLL, Segregate even & odd nodes in a LL , Merge sort for DLL ,Minimum Stack, The Celebrity problem, Iterative Tower of Hanoi Stock

Span problem, Priority Queue using DLL, Sort without extra Space, Max Sliding Window, Stack permutations		
Module:7	**Trees, Graphs , Heaps, Maps**	**6 hours**
Recover the BST, Views of tree Vertical order traversal ,Boundary traversal, BFS, DFS, Dial's Algorithm ,Bellman-Ford Algorithm, Topological Sort ,Heap Sort Binomial heap, K-array heap, Winner tree, Hash Map to Tree Map.		
Module:8	**Interview Preparation**	**3 hours**
Networking, Security, Operating Systems, Data Base Management Systems.		
Total Lecture hours		**45 hours**

Text Book	
1.	Mark Allen Weiss, “Data structures and algorithm analysis in C++”, 2019, 4th Edition, Pearson Education.
Reference Books	
1.	J.P. Tremblay and P.G. Sorenson, “An Introduction to Data Structures with applications”, 2017, Second Edition, Tata Mc Graw Hill.
2.	Richard M. Reese, Jennifer L. Reese, Alexey Grigorev, Java: Data Science Made Easy, 2019 Pocket Publishing.
Mode of Evaluation: CAT, Written assignment, Quiz, Project & FAT.	

Recommended by Board of Studies	24-02-2023		
Approved by Academic Council	No. 69	Date	16-03-2023

Course code	Course Title	L	T	P	C
MENG501P	Technical Report Writing	0	0	4	2
Pre-requisite	Nil	Syllabus version			
		1.0			

Course Objectives

1.To develop writing skills for preparing technical reports.
2. To analyze and evaluate general and complex technical information.
3. To enable proficiency in drafting and presenting reports.

Course Outcome

At the end of the course, the student will be able to
1.Construct error free sentences using appropriate grammar, vocabulary and style.
2. Apply the advanced rules of grammar for proofreading reports.
3. Interpret information and concepts in preparing reports.
4. Demonstrate the structure and function of technical reports.
5. Improve the ability of presenting technical reports.

Indicative Experiments	
1.	**Basics of Technical Communication** General and Technical communication, Process of communication, Levels of communication
2.	**Vocabulary& Editing** Word usage: confusing words, Phrasal verbs Punctuation and Proof reading
3.	**Advanced Grammar** Shifts: Voice, Tense, Person, Number Clarity: Pronoun reference, Misplace and unclear modifiers
4.	**Elements of Technical writing** Developing paragraphs, Eliminating unnecessary words, Avoiding clichés and slang Sentence clarity and combining
5.	**The Art of condensation** Steps to effective precis writing, Paraphrasing and summarizing
6.	**Technical Reports:** Meaning, Objectives, Characteristics and Categories
7.	**Formats of reports and Prewriting**: purpose, audience, sources of information, organizing the material
8.	**Data Visualization** Interpreting Data - Graphs - Tables – Charts - Imagery - Info graphics
9.	**Systematization of Information:** Preparing Questionnaire Techniques to Converge Objective-Oriented data in Diverse Technical Reports
10.	**Research and Analyses:** Writing introduction and literature review, Reference styles, Synchronize Technical Details from Magazines, Articles and e-content
11..	**Structure of Reports** Title – Preface – Acknowledgement - Abstract/Summary – Introduction - Materials and Methods – Results – Discussion - Conclusion - Suggestions/Recommendations
12.	**Writing the Report:** First draft, Revising, Thesis statement, Developing unity and coherence
13.	**Writing scientific abstracts:** Parts of the abstract, Revising the abstract Avoiding Plagiarism, Best practices for writers
14.	**Supplementary Texts** Appendix – Index – Glossary – References – Bibliography - Notes
15	**Presentation**

	Presenting Technical Reports Planning, creating anddigital presentation of reports			
			Total Laboratory hours :	**60 hours**
Text Book(s)				
1.	Raman, Meenakshi and Sangeeta Sharma, (2015).Technical Communication: Principles and Practice, Third edition, Oxford University Press, New Delhi.			
Reference Books				
1.	Aruna, Koneru, (2020). English Language Skills for Engineers. McGraw Hill Education, Noida.			
2.	Rizvi,M. Ashraf (2018)Effective Technical Communication Second Edition. McGraw Hill Education, Chennai.			
3.	Kumar, Sanjay and Pushpalatha, (2018). English Language and Communication Skills for Engineers, Oxford University Press.			
4.	Elizabeth Tebeaux and Sam Dragga, (2020).The Essentials of Technical Communication, Fifth Edition, Oxford University Press.			
Mode of Evaluation **:** Continuous Assessment Tests, Quizzes, Assignment, Final Assessment Test				
Recommended by Board of Studies	19-05-2022			
Approved by Academic Council	No. 66	Date	16-06-2022	

Course Code	Course Title	L	T	P	C
MSTS501P	Qualitative Skills Practice	0	0	3	1.5
Pre-requisite	Nil	Syllabus version			
		1.0			

Course Objectives:

1. To develop the quantitative ability for solving basic level problems.
2. To improve the verbal and professional communication skills.

Course Outcome:

At the end of the course, the student will be able to

1. Execute appropriate analytical skills.
2. Solve problems pertaining to quantitative and reasoning ability.
3. Learn better vocabulary for workplace communication.
4. Demonstrate appropriate behavior in an organized environment.

Module:1	**Business Etiquette: Social and Cultural Etiquette; Writing Company Blogs; Internal Communications and Planning: Writing press release and meeting notes**	**9 hours**

Value, Manners- Netiquette, Customs, Language, Tradition, Building a blog, Developing brand message, FAQs', Assessing Competition, Open and objective Communication, Two way dialogue, Understanding the audience, Identifying, Gathering Information,. Analysis, Determining, Selecting plan, Progress check, Types of planning, Write a short, catchy headline, Get to the Point –summarize your subject in the first paragraph., Body– Make it relevant to your audience.

Module:2	**Time management skills**	**3 hours**

Prioritization, Procrastination, Scheduling, Multitasking, Monitoring, Working under pressure and adhering to deadlines

Module:3	**Presentation skills – Preparing presentation; Organizing materials; Maintaining and preparing visual aids; Dealing with questions**	**7 hours**

10 Tips to prepare PowerPoint presentation, Outlining the content, Passing the Elevator Test, Blue sky thinking, Introduction , body and conclusion, Use of Font, Use of Color, Strategic presentation, Importance and types of visual aids, Animation to captivate your audience, Design of posters, Setting out the ground rules, Dealing with interruptions, Staying in control of the questions, Handling difficult questions.

Module:4	**QuantitativeAbility-L1–Numberproperties; Averages; Progressions; Percentages; Ratios**	**11 hours**

Number of factors, Factorials, Remainder Theorem, Unit digit position, Tens digit position, Averages, Weighted Average, Arithmetic Progression, Geometric Progression, Harmonic Progression, increase and Decrease or Successive increase, Types of ratios and proportions.

Module:5	**Reasoning Ability - L1 – Analytical Reasoning**	**8 hours**

Data Arrangement (Linear and circular & Cross Variable Relationship), Blood Relations, Ordering / ranking / grouping, Puzzle test, Selection Decision table.

Module:6	**Verbal Ability -L1 – Vocabulary Building**	**7 hours**

Synonyms & Antonyms, One word substitutes, Word Pairs, Spellings, Idioms, Sentence completion, Analogies.		
	Total Lecture hours:	**45 hours**
Reference Books		
1.	Kerry Patterson, Joseph Grenny, Ron McMillan and Al Switzler, (2017).2nd Edition, Crucial Conversations: Tools for Talking when Stakesare High .McGraw-Hill Contemporary, Bangalore.	
2.	Dale Carnegie,(2016).How to Win Friends and Influence People. Gallery Books, New York.	
3.	Scott Peck. M, (2003). Road Less Travelled. Bantam Press, New York City.	
4.	SMART, (2018). Place Mentor, 1st edition. Oxford University Press, Chennai.	
5.	FACE, (2016). Aptipedia Aptitude Encyclopedia. Wiley publications, Delhi.	
6.	ETHNUS, (2013). Aptimithra. McGraw – Hill Education Pvt .Ltd, Bangalore.	
Websites:		
1.	**www.chalkstreet.com**	
2.	**www.skillsyouneed.com**	
3.	**www.mindtools.com**	
4.	**www.thebalance.com**	
5.	**www.eguru.ooo**	
Mode of Evaluation: Continuous Assessment Tests, Quizzes, Assignment, Final Assessment Test		
Recommended by Board of Studies	19-05-2022	
Approved by Academic Council	No.66	Date 16-06-2022

Course Code	Course Title	L	T	P	C
MSTS502P	Quantitative Skills Practice	0	0	3	1.5
Pre-requisite	Nil	Syllabus version			
		1.0			

Course Objectives:

1. To develop the students' advanced problem solving skills.
2. To enhance critical thinking and innovative skills.

Course Outcome:

At the end of the course, the student will be able to

1. Create positive impression during official conversations and interviews.
2. Demonstrate comprehending skills of various texts.
3. Improve advanced level thinking ability in general aptitude.
4. Develop emotional stability to tackle difficult circumstances.

Module:1	**Resume skills – Resume Template; Use of power verbs; Types of resume; Customizing resume**	**2 hours**

Structure of a standard resume, Content, color, font, Introduction to Power verbs and Write up, Quiz on types of resume, Frequent mistakes in customizing resume, Layout-Understanding different company's requirement, Digitizing career portfolio.

Module:2	**Interview skills – Types of interview; Techniques to face remote interviews and Mock Interview**	**3 hours**

Structured and unstructured interview orientation, Closed questions and hypothetical questions, Interviewers' perspective, Questions to ask/not ask during an interview, Video interview, Recorded feedback, Phone interview preparation, Tips to customize preparation for personal interview, Practice rounds.

Module:3	**Emotional Intelligence - L1 – Transactional Analysis; Brain storming; Psychometric Analysis; SWOT analysis**	**12 hours**

Introduction, Contracting, ego states, Life positions, Individual Brainstorming, Group Brainstorming, Stepladder Technique, Brain writing, Crawford's Slip writing approach, Reverse brainstorming, Star bursting, Charlette procedure ,Round robin brainstorming, Skill Test, Personality Test, More than one answer, Unique ways, SWOT analysis.

Module:4	**Quantitative Ability - L3–Permutation - Combinations; Probability; Geometry and menstruation; Trigonometry; Logarithms; Functions; Quadratic Equations; Set Theory**	**14 hours**

Counting, Grouping, Linear Arrangement, Circular Arrangements, Conditional Probability, Independent and Dependent Events, Properties of Polygon, 2D & 3D Figures, Area & Volumes, Heights and distances, Simple trigonometric functions, Introduction to logarithms, Basic rules of logarithms, Introduction to functions, Basic rules of functions, Understanding Quadratic Equations, Rules & probabilities of Quadratic Equations, Basic concepts of Venn Diagram.

Module:5	**Reasoning ability - L3 – Logical reasoning; Data Analysis and Interpretation**	**7 hours**

Syllogisms, Binary logic, Sequential output tracing, Crypto arithmetic, Data Sufficiency, Data Interpretation-Advanced, Interpretation tables, pie charts & bar chats.		
Module:6	**Verbal Ability - L3 – Comprehension and Critical reasoning**	**7 hours**
Reading comprehension, Para Jumbles, Critical Reasoning (a) Premise and Conclusion, (b) Assumption & Inference, (c) Strengthening & Weakening an Argument.		
	Total Lecture hours:	**45 hours**

Reference Books	
1.	Michael Farra and JIST Editors,(2011).Quick Resume & Cover Letter Book: Write and Use an Effective Resume in Just One Day. Jist Works, Saint Paul, Minnesota.
2.	Flage Daniel E, (2003).The Art of Questioning: An Introduction to Critical Thinking. Pearson, London.
3.	David Allen, (2015).Getting Things done: The Art of Stress-Free productivity. Penguin Books, New York City.
4.	SMART, (2018). Place Mentor 1st edition. Oxford University Press, Chennai.
5.	FACE, (2016).Aptipedia Aptitude Encyclopedia. Wileypublications, Delhi.
6.	ETHNUS, (2013).Aptimithra. McGraw-Hill Education Pvt Ltd, Bangalore.
Websites:	
1.	www.chalkstreet.com
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Mode of Evaluation: Continuous Assessment Tests, Quizzes, Assignment, Final Assessment Test			
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