OFFICE OF THE REGISTRAR :: DIBRUGARH UNIVERSITY :: DIBRUGARH

Ref. No. DU/DR-A/137th AC/DUIET/Syllabus(revised)/M.Tech.(ECE)/2026/829 Date: 27.08.2026

NOTIFICATION

As recommended by the meeting of the ***Board of Studies (BoS) in Electronics and Communication Engineering*** and 161st Meeting of the Post Graduate Board, D.U. held on 23.06.2026, the Academic Council, Dibrugarh University in its 137th meeting held on 29.06.2026 ***vide Resolution No. 18*** has approved the ***revised syllabus for 1st and 2nd Semester of M. Tech. Programme in Electronics and Communication Engineering***, DUIET with effect from 2026-2027 onwards.

The syllabus is attached herewith.

Issued with due approval.

27/08/26

Deputy Registrar (Academic) i/c
Dibrugarh University

Copy forwarded for kind information and necessary action to:

1. The Hon'ble Vice-Chancellor, Dibrugarh University.
2. The Deans, Dibrugarh University.
3. The Registrar, Dibrugarh University.
4. The Controller of Examinations, Dibrugarh University.
5. The Director i/c, Dibrugarh University Institute of Engineering and Technology (DUIET), Dibrugarh University.
6. The Head, Department of Electronics and Communication Engineering, DUIET, Dibrugarh University.
7. The Joint / Deputy Controller of Examinations – 'C' / 'A' & 'B', Dibrugarh University.
8. The Senior Programmer, Dibrugarh University with a request to upload the Notification along with attached syllabi on the DU website.
9. File.

27/08/26

Deputy Registrar (Academic) i/c
Dibrugarh University

MODEL CURRICULUM

Engineering & Technology PG Course

(2026 onwards)

DEPARTMENT OF ELECTRONICS
&
COMMUNICATION ENGINEERING
DUIET

Specialisation in:

Internet of Things (IoT) & Sensor Systems

ALL INDIA COUNCIL FOR TECHNICAL EDUCATION

M. Tech. (Electronics & Telecommunication) Specialization: IoT and Sensor Systems

Semester I

Sl. No.	Course Code	Course Name	Scheme of Studies			Credits
			L	T	P	
1	M-EC101	Sensor Technologies and Signal Conditioning	3	0	0	3
2	M-EC102	Embedded Systems for Intelligent Devices	3	0	0	3
3	M-ECElv101	Program Elective - I	3	0	0	3
4	M-ECElv102	Program Elective - II	3	0	0	3
5	M-ECElv103	Program Elective - III	3	0	0	3
6	M-ECEL101	Advanced Embedded System Lab	0	0	4	2
7	M-ECEL102	Sensors' Lab	0	0	4	2

Semester II

Sl. No.	Course Code	Course Name	Scheme of studies per week			Credits
			L	T	P	
1	M-EC201	Wireless Sensor Networks and IoT Systems	3	0	0	3
2	M-EC202	Machine Learning for Sensor Data Analytics	3	0	0	3
3	M-ECElv201	Program Elective – III	3	0	0	3
4	M-ECElv202	Program Elective – IV	3	0	0	3
5	MECEL201	IoT and Application Lab	0	0	4	2
6	MECEL202	Signal Processing and ML Lab	0	0	4	2
7	MECEP201	Mini Project	2	0	0	2

Semester III

Sl. No.	Course Code	Course Name	Scheme of Studies Periods Per Week			Credits
			L	T	P	
1.	M-ECED301	Dissertation Phase – I	0	0	32	16

Semester IV

Sl. No.	Course Code	Course Name Credits	Scheme of Studies Periods Per Week			Credits
			L	T	P	
1.	MECED302	Dissertation Phase – II	0	0	32	16

Program Elective Subjects:

1. Advanced Wireless Communication
2. Wireless Communication for Sensor Networks
3. Data Acquisition and Signal Analysis
4. Machine Learning for Communication Systems
5. Fiber Optic Sensors and Photonics
6. Advanced Semiconductor Devices
7. Semiconductor Manufacturing
8. VLSI Design for Embedded Systems
9. RF and Microwave Sensors
10. Deep Learning for Intelligent Systems
11. Audio and Speech Signal Processing
12. Drone Communication and Sensor System

List of Laboratories:

1. Sensors and Application Lab
2. Advanced Embedded System Lab
3. IoT Application Lab
4. Signal Processing and ML Lab

MTECH COURSE SYLLABUS

1ST SEMESTER

Course Code	Course Title		T	P	C
M-EC101	**Sensor Technologies and Signal Conditioning**	**3**	**0**	**0**	**3**

Module: 1
Sensor fundamentals and characteristics **8 hours**
Sensor Classification, Performance and Types, Error Analysis characteristics, Optical Sources and Detectors and Intensity Polarization and Interferometric Sensors**,** Electronic and Optical properties of semiconductor as sensors, LED, Semiconductor lasers, Fiber optic sensors, Thermal detectors, Photo multipliers, photoconductive detectors, Photo diodes, Avalanche photodiodes, CCDs.
Intensity sensor, Microbending concept, Interferometers, Mach Zehnder, Michelson, Fabry- Perot and Sagnac, Phase sensor: Phase detection, Polarization maintaining fibers.

Module:2
Strain, Force, Torque and Pressure sensors **10 hours**
Strain gages, strain gage beam force sensor, piezoelectric force sensor, load cell, torque sensor, Piezo-resistive and capacitive pressure sensor, optoelectronic pressure sensors, vacuum sensors. Design of signal conditioning circuits for strain gauges, piezo, capacitance and optoelectronics
Sensors

Module:3
Position, Direction, Displacement and Level sensors **10 hours**
Potentiometric and capacitive sensors, Inductive and magnetic sensor, LVDT, RVDT, eddy current, transverse inductive, Hall effect, magneto resistive, magnetostrictive sensors. Fiber optic liquid level sensing, Fabry Perot sensor, ultrasonic sensor, capacitive liquid level sensor. Signal condition circuits for reactive and self generating sensors.

Module:4
Velocity and Acceleration sensors and Flow, Temperature and Acoustic sensors **10 hours**
Electromagnetic velocity sensor, Doppler with sound, light, Accelerometer characteristics,capacitive, piezo-resistive, piezoelectric accelerometer, thermal accelerometer, rotor, monolithic and optical gyroscopes, Flow sensors: pressure gradient technique, thermal transport, ultrasonic, electromagnetic andLaser anemometer. microflow sensor, coriolis mass flow and drag flow sensor. Temperature sensors- thermoresistive, thermoelectric, semiconductor and optical. Piezoelectric temperaturesensor. Acoustic sensors- microphones-resistive, capacitive, piezoelectric.

Text Book(s)

1. Jacob Fraden, Handbook of Modern Sensors: Physics, Designs, and Applications, 5th Edition, Springer Cham, 2016.
2. Jon S. Wilson, Sensor Technology Handbook, 1st Edition, Elsevier/Newnes, 2004.

Reference Books

1. Gerd Keiser, Optical Fiber Communications, 5th Edition, McGraw-Hill Education, 2017.
2. John G. Webster and Halit Eren, Measurement, Instrumentation, and Sensors Handbook, 2nd Edition, Two-Volume Set, CRC Press/Taylor & Francis, 2014.
3. Eric Udd and William B. Spillman Jr., Fiber Optic Sensors: An Introduction for Engineers and Scientists, 3rd Edition, Wiley, 2024.
4. Bahaa E. A. Saleh and Malvin Carl Teich, Fundamentals of Photonics, 3rd Edition, Wiley, 2019.

Course Code	Course Title	L	T	P	C
M-EC102	**Embedded Systems for Intelligent Devices**	**3**	**0**	**0**	**3**

Module 1: **8 Hours**

Fundamentals of Embedded Systems and IoT: Introduction to embedded systems, characteristics, classification, and architecture. Embedded processors, memory organisation, sensors, actuators, and power management. Fundamentals of the Internet of Things (IoT), IoT architecture, design methodology, and application domains. Overview of embedded platforms such as Arduino, ESP32, Raspberry Pi, and ARM-based systems. Hardware-software co-design principles and design constraints for IoT devices.

Module 2: **10 Hours**

Microcontroller Programming and Interfacing: Embedded C programming concepts, digital and analog I/O, timers, counters, interrupts, ADC, and PWM. Interfacing sensors, actuators, displays, and communication modules. Serial communication protocols including UART, SPI, I²C, and CAN. Introduction to embedded software design, debugging, testing, and reliability considerations. Fundamentals of Real-Time Operating Systems (RTOS), task management, scheduling, and inter-process communication.

Module 3: **10 Hours**

IoT Communication, Connectivity and Security: Wireless communication technologies including Wi-Fi, Bluetooth Low Energy (BLE), Zigbee, LoRaWAN, and NB-IoT. TCP/IP fundamentals and IoT application protocols such as MQTT, CoAP, and HTTP/HTTPS. Cloud and edge computing concepts for IoT systems. Security challenges in IoT devices, authentication, encryption, secure communication, secure boot, and firmware update mechanisms.

Module 4: **10 Hours**

IoT System Design and Applications: Design and implementation of end-to-end IoT systems, data acquisition, processing, and cloud integration. Introduction to TinyML and embedded AI for intelligent edge devices. Industrial IoT (IIoT), cyber-physical systems, and smart monitoring applications. Case studies in smart homes, healthcare, agriculture, smart cities, and Industry 4.0. Emerging trends and research challenges in embedded IoT systems.

Text Book(s)

1. Shibu K. V., Introduction to Embedded Systems, 2nd Edition, McGraw Hill Education India, 2017.
2. Arshdeep Bahga and Vijay Madisetti, Internet of Things: A Hands-On Approach, 1st Edition, Universities Press, 2015.

Reference Books

1. Qing Li and Caroline Yao, Real-Time Concepts for Embedded Systems, 1st Edition, CMP Books / Elsevier / CRC Press, 2003.
2. Perry Xiao, Designing Embedded Systems and the Internet of Things (IoT) with the ARM mbed, 1st Edition, Wiley, 2018.

2ND SEMESTER

Course Code	**Course Title**	**L**	**T**	**P**	**C**
M-EC202	**Machine Learning for Sensor Data Analytics**	**3**	**0**	**0**	**3**

Module:1 Foundations of Machine Learning **8 hours**

Introduction to ML: types of learning; Probability and statistics review; Linear algebra essentials; Bias-variance trade-off; Overfitting and regularization; Training, validation and testing; Cross-validation; Performance metrics: accuracy, precision, recall, F1-score, ROC-AUC, MSE, MAE.

Module:2 Supervised Learning **10 hours**

Linear and logistic regression; Regularization: Ridge, Lasso, Elastic Net; Decision trees and random forests; Support Vector Machines: linear and kernel-based; Naive Bayes; K-Nearest Neighbors; Ensemble methods: bagging, boosting (AdaBoost, Gradient Boosting, XGBoost); Hyperparameter tuning.

Module:3 Unsupervised Learning and Feature Engineering **10 hours**

Clustering: K-means, hierarchical, DBSCAN, Gaussian Mixture Models; Dimensionality reduction: PCA, ICA, t-SNE, UMAP; Anomaly detection: Isolation Forest, One-Class SVM, Autoencoders; Feature extraction for sensor data: time-domain, frequency-domain, time-frequency, statistical features; Feature selection methods.

Module:4 Deep Learning for Sensor Data **10 hours**

Artificial neural networks and backpropagation; Convolutional Neural Networks (CNN): 1D CNN for time-series; Recurrent Neural Networks: LSTM, GRU; Sequence-to-sequence models; Transformer architecture basics; Transfer learning; Frameworks: TensorFlow, PyTorch, Keras. Human activity recognition from IMU data; Predictive maintenance using vibration and acoustic sensors; Anomaly detection in industrial sensor data; Health monitoring from wearables (ECG, PPG, EEG); Environmental monitoring; Time-series forecasting; Federated learning for distributed sensor networks; Edge ML deployment.

Text Book(s)

1. Christopher M. Bishop, Pattern Recognition and Machine Learning, Springer, 2006.
2. V. Kotu and B. Deshpande, Data Science: Concepts and Practice, 3rd ed., Elsevier India, 2023.
3. A. Kulkarni and A. Deshpande, Machine Learning Foundations: A Case Study Approach, 2nd ed., Wiley India, 2024.
4. S. Raschka, Y. Liu, and V. Mirjalili, Machine Learning with PyTorch and Scikit-Learn, 2nd ed., Packt Publishing, 2024.

Reference Books

1. Aurelien Geron, Hands-On Machine Learning with Scikit-Learn, Keras and TensorFlow, 3rd Edition, O'Reilly, 2022.
2. Kevin P. Murphy, Probabilistic Machine Learning: An Introduction, MIT Press, 2022.
3. Trevor Hastie, Robert Tibshirani and Jerome Friedman, The Elements of Statistical Learning, 2nd Edition, Springer, 2009.

Course Code	Course Title	L	T	P	C
M-EC201	**Wireless Sensor Networks and IoT Systems**	**3**	**0**	**0**	**3**

Module 1— Fundamentals of Wireless Sensor Networks and IoT Architecture (8 hours)

Evolution of Wireless Sensor Networks (WSNs) and Internet of Things (IoT); characteristics and design challenges of WSNs; sensor node architecture — sensing unit, processing unit, transceiver and power unit; network architectures — flat, hierarchical and cluster-based architectures; IoT architecture — perception, network, middleware and application layers; IoT ecosystem and enabling technologies; IoT communication models; applications of WSNs and IoT in smart cities, agriculture, healthcare, industrial automation and environmental monitoring.

Module 2 — Communication Technologies and Networking for IoT Systems (10 hours)

Wireless communication requirements for IoT systems; IEEE 802.15.4 standard; ZigBee protocol stack; Bluetooth Low Energy (BLE); Wi-Fi for IoT applications; LoRa and LoRaWAN architecture; NB-IoT and LTE-M technologies; 6LoWPAN and IPv6 integration; gateway and edge devices; medium access control protocols; routing protocols for sensor networks; quality of service (QoS) requirements and performance evaluation of IoT communication systems.

Module 3 — IoT System Design, Data Management and Security (10 hours)

IoT system design methodology; embedded platforms for IoT applications; sensor interfacing and data acquisition; cloud and edge computing for IoT; IoT middleware and service-oriented architecture; data collection, aggregation and storage; MQTT, CoAP and REST-based communication protocols; cybersecurity challenges in IoT systems; authentication, authorization and access control; data privacy and secure communication mechanisms; blockchain concepts for IoT security.

Module 4 — Advanced IoT Applications and Emerging Trends (10 hours)

Industrial Internet of Things (IIoT); smart manufacturing and Industry 4.0; machine learning and artificial intelligence for IoT analytics; drone-assisted IoT systems and aerial sensor networks; digital twins and cyber-physical systems; smart energy and smart grid applications; healthcare IoT and wearable systems; edge intelligence and federated learning; sustainability and green IoT; recent research trends and future directions in WSN and IoT systems.

Suggested Text Books

1. S. Rani and A. Taneja, Eds., WSSN and IoT: An Integrated Approach for Smart Applications. Boca Raton, FL, USA: CRC Press, 2024.
2. Q. F. Hassan, Ed., Internet of Things A to Z: Technologies and Applications, 2nd ed. Hoboken, NJ, USA: Wiley-IEEE Press, 2026.
3. G. R. Kanagachidambaresan, Integration of WSN and IoT for Smart Cities. Cham, Switzerland: Springer Nature, 2020.

Reference Books

1. Sohraby K, Minoli D, Znati T. Wireless Sensor Networks: Technology, Protocols and Applications. 1st ed. Hoboken, NJ: John Wiley & Sons; 2007.
2. Karl H, Willig A. Protocols and Architectures for Wireless Sensor Networks. 1st ed. Chichester, UK: John Wiley & Sons; 2005.
3. Minerva R, Biru A, Rotondi D. Towards a Definition of the Internet of Things (IoT). IEEE Internet Initiative; 2015.

PROGRAM ELECTIVES

Course Code	**Course Title**	**L**	**T**	**P**	**C**
M-ECElv	**Data Acquisition and Signal Analysis**	**3**	**0**	**0**	**3**

Module:1 Data Acquisition System Architecture **8 hours**

Generalized DAQ system: sensor, signal conditioning, multiplexer, ADC, processor, storage; Sampling theorem and aliasing; Anti-aliasing filters; Quantization and quantization noise; Sample-and-hold; Multi-channel DAQ architectures; PC-based and standalone DAQ; LabVIEW and Python-based DAQ. Discrete-time signals and sequences; LTI systems: impulse response, convolution; Z-transform and its properties; Region of convergence; Inverse Z-transform; Transfer function and stability; Discrete-time Fourier transform (DTFT) and its properties; Frequency response of LTI systems.

Module:2 DFT, FFT and Spectral Analysis **10 hours**

Discrete Fourier Transform (DFT) and its properties; Fast Fourier Transform algorithms: DIT and DIF radix-2 FFT; Spectral leakage and windowing: rectangular, Hamming, Hanning, Blackman; Power spectral density estimation: periodogram, Welch and Bartlett methods; Cross-spectral density and coherence.

Module:3 Digital Filter Design **10 hours**

FIR filter design: windowing method, frequency sampling, Parks-McClellan; Linear phase property; IIR filter design: impulse invariance, bilinear transformation; Butterworth, Chebyshev and elliptic filters; Filter structures: direct, cascade, parallel, lattice; Finite word-length effects; Multirate signal processing: decimation, interpolation, polyphase.

Module:4 Advanced Signal Analysis **10 hours**

Short-Time Fourier Transform (STFT) and spectrograms; Wavelet transform: continuous and discrete; Multi-resolution analysis; Empirical Mode Decomposition; Statistical signal processing: mean, variance, autocorrelation, ergodicity; Adaptive filters: LMS and RLS algorithms; Applications in noise cancellation, system identification and feature extraction for sensor signals.

Text Book(s)

1. J. G. Proakis and D. G. Manolakis, Digital Signal Processing: Principles, Algorithms and Applications, Pearson India Reprint Edition, 2021.
2. V. Oppenheim and R. W. Schafer, Discrete-Time Signal Processing, 3rd ed. Noida, India: Pearson India, Reprint Edition, 2021.

Reference Books

1. Sanjit K. Mitra, Digital Signal Processing: A Computer-Based Approach, 4th Edition, McGraw-Hill, 2013.
2. Maurice Bellanger, Digital Processing of Signals: Theory and Practice, 3rd Edition, Wiley, 2000.
3. Steven W. Smith, The Scientist and Engineer's Guide to Digital Signal Processing, California Technical Publishing, 1997.

Course Code	**Course Title**	**L**	**T**	**P**	**C**
M-ECElv	**Machine Learning for Communication Systems**	**3**	**0**	**0**	**3**

Module:1 Introduction to ML for Communications **8 hours**

Motivation for ML in communications; Overview of ML techniques: supervised, unsupervised, reinforcement learning; Deep learning recap; Communication system primer; ML applications in PHY, MAC, network and application layers; End-to-end learning paradigm.

Module:2 Deep Learning for Physical Layer **10 hours**

Autoencoder-based end-to-end communication; Deep learning for modulation classification; ML for channel estimation and equalization; Deep learning-based decoder for channel codes; Belief propagation neural networks; OFDM receiver design using DL.

Module:3 ML for Channel Modeling and Beamforming **10 hours**

Generative models for channel: GANs, VAEs; ML-based channel prediction; Deep learning for massive MIMO precoding and beamforming; CSI feedback compression using autoencoders; Hybrid beamforming with ML; mmWave beam management using ML.

Module:4 Reinforcement Learning for Network Optimization **10 hours**

Markov Decision Processes (MDP); Q-learning, SARSA, Deep Q-Networks; Policy gradient methods; Actor-critic methods; Multi-agent RL; Applications: dynamic spectrum access, power control, scheduling, handover management. ML for network slicing and orchestration; Federated learning in wireless networks; Edge ML and over-the-air computing; Explainable AI for communications; Model deployment and complexity considerations; Datasets and benchmarks; Case studies in 5G and emerging 6G.

Text Book(s)

1. Osvaldo Simeone, Machine Learning for Engineers, Cambridge University Press, 2022.
2. C. Huyen, Designing Machine Learning Systems: An Iterative Process for Production-Ready Applications. Hoboken, NJ, USA: O'Reilly Media, 2022. Indian Reprint Edition, Wiley India Pvt. Ltd.

Reference Books

1. Yiwen Sun et al., Machine Learning for Wireless Communications, Cambridge University Press, 2022.
2. Richard S. Sutton and Andrew G. Barto, Reinforcement Learning: An Introduction, 2nd Edition, MIT Press, 2018.
3. Selected papers from IEEE JSAC, TCOM, TWC and ICC/Globecom.

Course Code	**Course Title**	**L**	**T**	**P**	**C**
M-ECElv	**Semiconductor Manufacturing**	**3**	**0**	**0**	**3**

Module:1 Overview of Semiconductor Manufacturing **8 hours**

Evolution of semiconductor industry; CMOS process flow overview; Wafer manufacturing: Czochralski and float-zone methods; Wafer specifications and defects; Cleanroom classification, contamination control; Wafer cleaning: RCA clean and HF dip.

Module:2 Lithography **10 hours**

Optical lithography: principles, resolution, depth of focus; Photoresists: positive and negative; Exposure systems: contact, proximity, projection (steppers, scanners); Immersion lithography; Resolution enhancement techniques: OPC, PSM, double patterning; EUV lithography; E-beam and nanoimprint lithography; Mask making and inspection.

Module:3 Etching, Deposition and Doping **10 hours**

Wet and dry etching; RIE, ICP, ALE; Etch selectivity, anisotropy, loading; Thin film deposition: thermal oxidation, CVD (LPCVD, PECVD), ALD, PVD (sputtering, evaporation), epitaxy (MBE, MOCVD); Doping: ion implantation and diffusion; Rapid thermal annealing; Silicide formation.

Module:4 Packaging, Yield and Emerging Trends **10 hours**

Wafer testing and probe; Wafer dicing, die attach, wire bonding, flip-chip; Advanced packaging: 2.5D and 3D ICs, TSV, fan-out wafer-level packaging; Heterogeneous integration and chiplets; Yield models and learning curves; Failure analysis; Fab economics; Sustainable and green manufacturing.

Textbook(s)

1. James D. Plummer, Michael D. Deal and Peter B. Griffin, Silicon VLSI Technology: Fundamentals, Practice and Modeling, 1st Edition, Prentice Hall / Pearson, 2000.
2. Stephen A. Campbell, Fabrication Engineering at the Micro- and Nanoscale, 5th Edition, Oxford University Press, 2020.

Reference Books

1. Peter Van Zant, Microchip Fabrication: A Practical Guide to Semiconductor Processing, 6th Edition, McGraw-Hill Education, 2014.
2. Hong Xiao, Introduction to Semiconductor Manufacturing Technology, 2nd Edition, SPIE Press, 2012.
3. Gary S. May and Costas J. Spanos, Fundamentals of Semiconductor Manufacturing and Process Control, 1st Edition, Wiley-Interscience / John Wiley & Sons, 2006.

Course Code	**Course Title**	**L**	**T**	**P**	**C**
M-ECElv	**Deep Learning for Intelligent Systems**	**3**	**0**	**0**	**3**

Module:1 Foundations of Deep Learning **8 hours**

From perceptron to multi-layer networks; Activation functions; Backpropagation; Loss functions; Optimization: SGD, momentum, RMSProp, Adam, AdamW; Regularization: dropout, batch normalization, weight decay; Initialization strategies; Hyperparameter tuning; PyTorch and TensorFlow basics.

Module:2 Convolutional Neural Networks **10 hours**

Convolution and pooling operations; CNN architectures: LeNet, AlexNet, VGG, GoogLeNet, ResNet, DenseNet, EfficientNet; Object detection: R-CNN family, YOLO, SSD, DETR; Semantic segmentation: FCN, U-Net, DeepLab; Vision transformers (ViT, Swin); Transfer learning and fine-tuning.

Module:3 Sequence Models and Attention **10 hours**

Recurrent Neural Networks: vanilla RNN, LSTM, GRU; Bidirectional and deep RNNs; Sequence-to-sequence models; Attention mechanism; Transformer architecture: self-attention, multi-head attention, positional encoding; BERT, GPT family; Sequence modeling for time-series and NLP.

Module:4 Generative Models and Self-Supervised Learning **10 hours**

Autoencoders and variational autoencoders; Generative Adversarial Networks (GAN) and variants (DCGAN, StyleGAN, cGAN); Diffusion models; Normalizing flows; Self-supervised learning: contrastive learning (SimCLR, MoCo), masked modeling (MAE); Representation learning. Large Language Models: pre-training, fine-tuning, RLHF, instruction tuning; Multimodal models: Responsible AI: fairness, interpretability, robustness; Deployment of DL models.

Textbook(s)

1. Ian Goodfellow, Yoshua Bengio and Aaron Courville, Deep Learning, 1st Edition, MIT Press, 2016.
2. Aston Zhang, Zachary C. Lipton, Mu Li and Alexander J. Smola, Dive into Deep Learning, 1st Edition, Cambridge University Press, 2023.

Reference Books

1. François Chollet, Deep Learning with Python, 3rd Edition, Manning Publications, 2026.
2. Eli Stevens, Luca Antiga and Thomas Viehmann, Deep Learning with PyTorch, 1st Edition, Manning Publications, 2020.
3. Christopher M. Bishop and Hugh Bishop, Deep Learning: Foundations and Concepts, 1st Edition, Springer, 2024.

Course Code	**Course Title**	**L**	**T**	**P**	**C**
M-ECElv	**Audio and Speech Signal Processing**	**3**	**0**	**0**	**3**

Module:1 Audio and Speech Fundamentals **8 hours**

Human auditory system and psychoacoustics; Speech production mechanism: source-filter model; Phonetics and phonology basics; Speech signal characteristics; Sampling, quantization and digital audio formats; Audio coding standards (MP3, AAC, Opus); Acoustic features: pitch, formants, intensity, voice quality.

Module:2 Speech Analysis and Feature Extraction **10 hours**

Short-time analysis: windowing, frame-rate processing; Time-domain features: energy, zero-crossing rate, autocorrelation; Frequency-domain features: STFT, spectrogram; Cepstral analysis: real and complex cepstrum, MFCCs, PLP; LPC analysis and LSP; Pitch and formant estimation; Voice activity detection.

Module:3 Speech Enhancement and Coding **10 hours**

Speech enhancement: spectral subtraction, Wiener filtering, MMSE estimators; Microphone array processing; Acoustic echo cancellation; Beamforming for speech; Speech coding: waveform coding (PCM, ADPCM), parametric coding (LPC vocoders), hybrid coding (CELP); Modern neural audio coders.

Module:4 Automatic Speech Recognition and TTS **10 hours**

ASR overview; Acoustic modeling: HMM-GMM systems; HMM training (Baum-Welch) and decoding (Viterbi); Language modeling: n-gram, neural LMs; DNN-HMM hybrid systems; End-to-end ASR: CTC, attention-based encoder-decoder, RNN-T, Conformer; Self-supervised speech models (wav2vec, HuBERT); WFST decoding briefly. Text-to-Speech systems: concatenative, parametric (HMM), neural TTS (Tacotron, FastSpeech, VITS); Neural vocoders (WaveNet, WaveGlow, HiFi-GAN); Speaker recognition and verification; Speaker diarization; Music information retrieval basics; Audio scene classification and sound event detection; Audio applications: voicebots, transcription, accessibility.

Textbook(s)

1. Lawrence R. Rabiner and Ronald W. Schafer, Theory and Applications of Digital Speech Processing, 1st Edition, Pearson, 2011.
2. Daniel Jurafsky and James H. Martin, Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition with Language Models, 3rd Edition, Online Manuscript, released January 6, 2026.

Reference Books

1. Xuedong Huang, Alex Acero and Hsiao-Wuen Hon, Spoken Language Processing: A Guide to Theory, Algorithm, and System Development, 1st Edition, Prentice Hall PTR, 2001.
2. Thomas F. Quatieri, Discrete-Time Speech Signal Processing: Principles and Practice, 1st Edition, Prentice Hall PTR, 2001.

Course Code	Course Title	L	T	P	C
M-ECElv	**Advanced Wireless Communication**	**3**	**0**	**0**	**3**

Module-1 **8 hours**

Basics of single-user System, Diversity System, Multiple-Input-Multiple-Output (MIMO) communications – Channel models, outage capacity, ergodic capacity – Diversity techniques: time, frequency, space and diversity combiners – Precoding for spatial multiplexing, optimum, linear and nonlinear receivers – Space-time coding and MIMO decoding

Module-2 **10 hours**

Fading Channels, Different Fading Models, Advanced Fading Models, Design of a mathematical fading model, Introduction to Mathematica Soft., Basic of Communication and Signal Processing MATLAB Tool Box, Random variables and Channel Design, Design and analysis of Wireless Communication Channels in fading environment.

Module-3 **10 hours**

The 5G architecture: Introduction, NFV and SDN, Basics about RAN architecture, High-level requirements for the 5G architecture, Functional architecture and 5G flexibility, Functional split criteria, Functional split alternatives, Functional optimization for specific applications, Integration of LTE and new air interface to fulfil 5G Requirements, Enhanced Multi-RAT coordination features, Physical architecture and 5G deployment.

Module-4 **10 hours**

Emerging techniques and applications in 5G – Recent advances in MIMO: massive MIMO and millimeter wave MIMO – Internet of Things (IoT) networks and Low Power Wide Area Network (LPWAN) technologies (Lora, SigFox, LTE-M, EC-GSM-IoT, NB-IoT) – Other topics: Caching, Device-to-device (D2D) communications, Massive IoT, Ultra-Reliable Low-Latency Communication (URLLC), Green and energy efficient communications, Mobile Cloud/Edge/Fog computing and C-RAN architectures.

Text Book/Reference Book:

[1] T. S. Rappaport, Wireless Communications: Principles and Practice, 2nd ed. Noida, India: Pearson India, Reprint Edition, 2023.

[2] A. Goldsmith, Wireless Communications, Indian ed. New Delhi, India: Cambridge University Press India, Reprint Edition, 2021.

[3] V. K. Garg, Wireless Communications and Networking, 2nd ed. San Francisco, CA, USA: Morgan Kaufmann (Elsevier India Edition), 2021.

Reference Books:

[1] Y. G. Li and G. L. Stüber, Orthogonal Frequency Division Multiplexing for Wireless Communications, 2nd ed. New York, NY, USA: Springer, 2022

[2] E. Dahlman, S. Parkvall, and J. Sköld, 5G NR: The Next Generation Wireless Access Technology, 2nd ed. London, U.K.: Academic Press (Elsevier), 2021.

[3] A. F. Molisch, Wireless Communications, 3rd ed. Hoboken, NJ, USA: John Wiley & Sons, 2023.

Course Code	Course Title	L	T	P	C
M-ECElv	**RF and Microwave Sensors**	**3**	**0**	**0**	**3**

Module:1 **8 hours**

RF Sensors : Microwave Antenna-Introduction, types of Antenna, fundamental parameters of antennas,radiation mechanism, Fresnel and Fraunhofer regions. Antenna for communication and Antenna for sensing, radiometer and radar

Module:2 : **10 hours**

Antenna for personal area communication: Concepts of Printed Antennas, Broadband Microstrip Patch Antennas, Antennas for WearableDevices, Design Requirements, Modeling and Characterization of Wearable Antennas, WBAN Radio Channel Characterization and Effect of Wearable Antennas, Domains of Operation, Sourceson the Human Body, Compact Wearable Antenna for different applications.

Module:3 : **10 hours**

Radar: Introduction to RADAR, RADAR range equation, MTI and pulse Doppler RADAR, Tracking**,** RADAR, SAR pulse RADAR, CW RADAR, **Applications of Radar:** Automotive, remote sensing, agriculture, medicine, detection of buried objects, NDT, defense factors affecting the performance of RADAR, RADAR transmitters, Receivers

Module:4 : **10 hours**

Radiometers: Radiative transfer theory, SMMR, Types of radiometers - and Bolometers, Applications in automotive, agriculture, medicine, weather forecasting, Microwave power Sensors: Diode Sensors: Diode detector principles, dynamic range average power sensors, signal waveform effects on the measurement uncertainty of diode sensors. Thermocouple Sensors: Principles of Thermocouple sensor, power meters for thermocouple sensors. RFID Sensors: Introduction, Components of RFID systems, hardware and software components, RFID standards, RFID applications.

Textbook(s)

1. Klaus Finkenzeller, RFID Handbook: Fundamentals and Applications in Contactless Smart Cards, Radio Frequency Identification and Near-Field Communication, 3rd Edition, John Wiley & Sons, 2010/2011.
2. Constantine A. Balanis, Antenna Theory: Analysis and Design, 4th Edition, John Wiley & Sons, 2016.

Reference Books

1. Bernhard Hofmann-Wellenhof, Herbert Lichtenegger and James Collins, GPS: Theory and Practice, 5th Revised Edition, Springer-Verlag Wien / Springer, 2001.
2. Thomas M. Lillesand, Ralph W. Kiefer and Jonathan W. Chipman, Remote Sensing and Image Interpretation, 7th Edition, Wiley, 2015.

Course Code	Course Title	L	T	P	C
M-ECElv	**Fiber Optics Sensors and Photonics**	**3**	**0**	**0**	**3**

Module:1 **8 hours**

Theory of Optical Waveguides

Wave theory of optical waveguides, formation of guided modes, Slab waveguide, Rectangular waveguide, Radiation fields from waveguide, Effective index method, Marcatili's method, Beam propagation method. Basic characteristic of Optical Fiber Waveguides, Acceptance angle, Numerical aperture, skewrays- Electromagnetic Modes in Cylindrical Waveguides.

Module:2 **10 hours**

Active and Passive Optical Components : Electro-optic and acousto optic wave guide devices, directional couplers, optical switch, phase and amplitude modulators,filtersetc,Yjunction,powersplitters,arrayedwaveguidedevices,fiberpigtailing, end-fiber prism coupling, FBG and fabrication of FBG,Tapered couplers.

Module:3 **10 hours**

Intensity and Polarization Sensors : Intensity sensor: Transmissive concept –Reflective concept- Micro bending concept–Transmission and Reflection with other optic effect-Interferometers –Mach Zehnder-Michelson-Fabry-Perot and Sagnac– Phase sensor: Phase detection-Polarization maintaining fibers. Displacement and temperature sensors: reflective and Micro bending Technology- Applications of displacement and temperature sensors.

Module:4 **10 hours**

Interferometric Sensors : Pressure sensors: Transmissive concepts, Microbending –Intrinsic concepts– Interferometric concepts, Applications. Flow sensors: Turbine flowmeters- Differential pressure flowsensors –Laser Doppler velocity sensors-Applications- Sagnac Interferometer for rotation sensing. Magnetic and electric field sensors: Intensity and phase modulation types– applications. **Fiber based Chemical Senors :** Fiber based Chemical Sensing, Absorption, Fluorescence, Chemi- luminescence, Vibrational, Spectroscopic, SPR. **Fiber based Bio-Sensors :** Fiber based Bio-molecules sensing: High Index, SPR, Hollow core fiber probes, Label Free bio-molecules.

Textbook(s)

1. David A. Krohn, Trevor W. MacDougall and Alexis Mendez, Fiber Optic Sensors: Fundamentals and Applications, 4th Edition, SPIE Press, 2015. ISBN: 9781628411805.
2. Eric Udd and William B. Spillman Jr., Fiber Optic Sensors: An Introduction for Engineers and Scientists, 3rd Edition, Wiley, 2024.

Reference Book(s)

1. Zujie Fang, Ken Chin, Ronghui Qu and Haiwen Cai, Fundamentals of Optical Fiber Sensors, 1st

Edition, Wiley, 2012. ISBN: 9780470575406.
2. Shizhuo Yin, Paul B. Ruffin and Francis T. S. Yu, Fiber Optic Sensors, 2nd Edition, CRC Press / Taylor & Francis, 2008.

Course Code	**Course Title**	**L**	**T**	**P**	**C**
M-ECElv	**Advanced Semiconductor devices**	**3**	**0**	**0**	**3**

Module-1 **8 hours**

Review of Fundamentals of Semiconductors: Semiconductor Materials and their properties Carrier Transport in Semiconductors Excess Carriers in Semiconductor

Module-2 **10 hours**

Junctions and Interfaces: Description of p-n junction, Action, The Abrupt Junction, Example of an Abrupt Junction, The linearly graded Junction. The Ideal Diode Model, Real Diodes, Temperature Dependence of I-V Characteristics, High Level Injection Effects, Example of Diodes. Description of Breakdown Mechanism, Zener and Avalanche Breakdown in p-n Junction

Module-3 **10 hours**

Majority Carrier Diodes: The Tunnel Diode, The Backward Diode, The Schottkey Barrier Diode, Ohmic Contacts Heterojunctions.

Module-4 **10 hours**

Microwave Diodes and: The Varactor Diode, The p-i-n Diode, The IMPATT Diode, TRAPATT Diode, The BARITT Diode, Transferred Electron Devices

Optoelectronic Devices: The Solar Cell, Photo detectors, Light Emitting Diodes, Semiconductor Lasers.

Metal Semiconductor Field Effect Transistors: Basic Types of MESFETs, Models for I-V Characteristics of Short – Channel MESFETs, High Frequency Performance, MESFETs Structures.

MOS Transistors and Charge Coupled Devices: Basic Structures and the Operating Principle, I-V Characteristics, Short- Channel Effects, MOSFET Structures, Charge Coupled Devices.

Text Book:

[1] D. A. Neamen, Semiconductor Physics and Devices: Basic Principles, 5th ed. New York, NY, USA: McGraw-Hill Education, 2022.

[2] S. M. Sze and M. K. Lee, Semiconductor Devices: Physics and Technology, 4th ed. Hoboken, NJ, USA: John Wiley & Sons, 2021.

[3] D. K. Schroder, Semiconductor Material and Device Characterization, 4th ed. Hoboken, NJ, USA: John Wiley & Sons, 2021.

Reference Books

[1] Y. Tsividis and C. McAndrew, Operation and Modeling of the MOS Transistor, 4th ed. New York, NY, USA: Oxford University Press, 2022.

[2] J. P. Colinge and C. A. Colinge, Physics of Semiconductor Devices, 2nd ed. New York, NY, USA: Springer, 2021.

[3] C. Hu, Modern Semiconductor Devices for Integrated Circuits, Reprint ed. Noida, India: Pearson India, 2021.

Course Code	Course Title	L	T	P	C
M-ECElv	**VLSI Design for Embedded Systems**	**3**	**0**	**0**	**3**

Module 1— VLSI Fundamentals and CMOS Circuit Design (8 hours)

Evolution of VLSI technology, Moore's law and its scaling implications; MOS transistor theory — threshold voltage, I-V characteristics, body effect, channel-length modulation; CMOS inverter — DC characteristics, noise margins, switching threshold, propagation delay, power dissipation; CMOS combinational logic — static CMOS, pass-transistor logic, transmission gates, complex gates; CMOS sequential elements — latches, flip-flops, registers; VLSI design flow — front-end and back-end; design abstractions and Y-chart; full-custom vs. semi-custom vs. structured ASIC design.

Module 2 — HDL-Based Design and Verification (10 hours)

Introduction to Verilog HDL — lexical conventions, data types, operators; modelling styles — gate-level, dataflow, behavioural, and structural; design of combinational circuits (adders, multiplexers, decoders, ALU); design of sequential circuits (counters, shift registers, memory elements); finite state machine design — Mealy and Moore models, state encoding; testbench development, stimulus generation, and simulation; principles of logic synthesis; introduction to SystemVerilog and assertion-based verification; brief introduction to VHDL for comparison.

Module 3 — FPGA and ASIC Implementation (10 hours)

FPGA architecture — Configurable Logic Blocks (CLBs), LUTs, switch matrices, I/O blocks, embedded memory and DSP blocks; overview of Xilinx (Spartan, Artix, Zynq) and Intel (Cyclone) families; FPGA design flow using Vivado/Quartus — synthesis, implementation, bitstream generation; ASIC design flow — RTL to GDSII, standard-cell libraries, floorplanning, placement, clock-tree synthesis, routing; static timing analysis — setup/hold, critical path; design for testability — scan chains, BIST; physical-design considerations for embedded chips.

Module 4 — Low-Power VLSI Design for IoT (10 hours)

Sources of power dissipation — dynamic, short-circuit, static, and leakage; power-delay product and energy efficiency metrics; low-power techniques at the architecture, RTL, gate, and circuit levels; clock gating, power gating, operand isolation; multi-Vt and multi-VDD design; Dynamic Voltage and Frequency Scaling (DVFS); subthreshold and near-threshold operation for ultra-low-power sensor nodes; leakage-reduction methods —

stack effect, sleep transistors, MTCMOS; introduction to energy harvesting circuits; power-management ICs and LDOs for IoT devices. System-on-Chip (SoC) design methodology, case studies — Bluetooth Low Energy SoC, sensor-hub MCU, energy-aware IoT chip.

Textbook(s)

1. Neil H. E. Weste and David Money Harris, CMOS VLSI Design: A Circuits and Systems Perspective, 4th Edition, Pearson, 2015.
2. Samir Palnitkar, Verilog HDL: A Guide to Digital Design and Synthesis, 2nd Edition, Pearson, 2003.
3. Kaushik Roy and Sharat C. Prasad, Low-Power CMOS VLSI Circuit Design, 1st Edition, Wiley, 2000.

Reference Books

1. Jan M. Rabaey, Anantha Chandrakasan and Borivoje Nikolic, Digital Integrated Circuits: A Design Perspective, 2nd Edition, Pearson, 2016.
2. Sudhakar Yalamanchili, Introductory VHDL: From Simulation to Synthesis, 1st Edition, Pearson, 2000/2001.
3. Steve Furber, ARM System-on-Chip Architecture, 2nd Edition, Pearson, 2015.
4. Michael John Sebastian Smith, Application-Specific Integrated Circuits, 1st Edition, Addison-Wesley / Pearson, 1997/2002.
5. Jan M. Rabaey, Low Power Design Essentials, 1st Edition, Springer, 2009.
6. Wayne Wolf, Modern VLSI Design: IP-Based Design, 4th Edition, Pearson / Prentice Hall, 2008/2009.

Course Code	**Course Title**	**L**	**T**	**P**	**C**
M-ECElv	**Wireless Communication for Sensor Networks**	**3**	**0**	**0**	**3**

Module 1 — Fundamentals of Wireless Communication for Sensor Networks (8 hours)

Introduction to wireless sensor networks (WSNs); evolution and applications of sensor networks; sensor node architecture and network architecture; communication requirements of sensor networks; wireless communication principles — electromagnetic spectrum, frequency bands, modulation concepts, signal propagation mechanisms; path loss, shadowing and multipath fading; link budget analysis; performance metrics — RSSI, SNR, BER, throughput, latency and packet delivery ratio; energy constraints and energy-efficient communication strategies in sensor networks.

Module 2 — MAC and Routing Protocols for Sensor Networks (10 hours)

Medium access control (MAC) concepts for sensor networks; contention-based and schedule-based MAC protocols; IEEE 802.15.4 MAC layer; energy-efficient MAC design; routing challenges in WSNs; flat, hierarchical and location-based routing architectures; data-centric routing protocols; cluster-based routing; energy-aware routing mechanisms; LEACH, PEGASIS and Directed Diffusion protocols; quality of service (QoS) considerations; network lifetime optimization techniques.

Module 3— Wireless Technologies and Networking Standards (10 hours)

Wireless communication standards for sensor networks; IEEE 802.15.4 physical and MAC layers; ZigBee architecture and protocol stack; Bluetooth Low Energy (BLE); 6LoWPAN; LoRa and LoRaWAN architecture; NB-IoT and LTE-M technologies; WirelessHART and industrial sensor networks; comparison of short-range and long-range communication technologies; gateway architectures; interoperability and integration with IoT platforms.

Module 4 — Advanced Sensor Network Systems and Applications (10 hours)

Wireless sensor networks for Internet of Things (IoT); edge and cloud-enabled sensor networks; machine learning applications in sensor networks; drone-assisted wireless sensor networks; smart agriculture and environmental monitoring systems; industrial IoT and smart manufacturing; healthcare monitoring applications; smart city deployments; security and privacy issues in sensor networks; emerging trends in next-generation sensor networks and research challenges.

Suggested Text Books:

[1] W. Dargie and C. Poellabauer, Fundamentals of Wireless Sensor Networks: Theory and Practice, 2nd ed. Hoboken, NJ, USA: John Wiley & Sons, 2022.

[2] A. Goldsmith, Wireless Communications, Indian Reprint ed. New Delhi, India: Cambridge University Press India, 2021.
[3] E. Dahlman, S. Parkvall, and J. Sköld, 5G NR: The Next Generation Wireless Access Technology, 2nd ed. London, U.K.: Academic Press (Elsevier), 2021.

Reference Books (IEEE Format)

[1] A. F. Molisch, Wireless Communications, 3rd ed. Hoboken, NJ, USA: John Wiley & Sons, 2023.
[2] H. Karl and A. Willig, Protocols and Architectures for Wireless Sensor Networks, Indian Reprint ed. New Delhi, India: Wiley India, 2021.
[3] Y. G. Li and G. L. Stüber, Orthogonal Frequency Division Multiplexing for Wireless Communications, 2nd ed. New York, NY, USA: Springer, 2022.

Course Code	Course Title	L	T	P	C
M-ECElv	**Drone Communication for Sensor Systems**	**3**	**0**	**0**	**3**

Module 1— Introduction to Drone Systems and Applications (8 hours)

Introduction to Unmanned Aerial Vehicles (UAVs); evolution of drone technology; classification of drones — multirotor, fixed-wing and hybrid drones; major components of a drone system; flight controller, propulsion system, battery and payload; overview of drone regulations in India; applications of drones in agriculture, surveying, disaster management, environmental monitoring, infrastructure inspection and smart cities.

Module 2 — Sensors and Communication Systems in Drones (10 hours)

Role of sensors in UAV systems; GPS/GNSS, accelerometer, gyroscope, magnetometer and barometer; camera and imaging sensors; sensor data acquisition and processing; fundamentals of drone communication; telemetry systems; command and control links; wireless communication technologies for drones — Wi-Fi, Bluetooth, ZigBee, LoRa and Cellular Communication; range, reliability and power considerations.

Module 3 — Drone-Based Sensor Applications and Data Collection (10 hours)

Drone-assisted sensing systems; aerial monitoring and data collection; drone applications in precision agriculture; crop health monitoring; pesticide and fertilizer spraying; land surveying and mapping; environmental monitoring; image acquisition and basic image interpretation; drone-enabled IoT systems; case studies of drone applications in India.

Module 4 — Practical Drone Operations and Mission Planning (10 hours)

Drone hardware familiarization; identification of drone subsystems; basic drone assembly concepts; battery charging and maintenance; pre-flight inspection procedures; flight controller calibration; GPS lock and sensor calibration; introduction to mission planning software; manual and autonomous flight modes; waypoint-based missions; aerial image and video acquisition; telemetry monitoring; safety procedures and operational guidelines; hands-on demonstrations for agricultural monitoring, mapping and inspection applications; practical troubleshooting and maintenance procedures.

Suggested Text Books

1. Austin R. Unmanned Aircraft Systems: UAVs Design, Development and Deployment. 2nd ed. John Wiley & Sons; 2021.
2. Tiwari N, Yadav S, Giri VK. Fundamentals of Drone/UAV Technology. 1st ed. New Delhi: S.K. Kataria & Sons; 2025. ISBN: 978-81-982470-1-8
3. Barnhart RK, Marshall DM, Shappee E (Eds.). Introduction to Unmanned Aircraft Systems. 3rd ed. Boca Raton, FL: CRC Press, Taylor & Francis Group; 2021

Reference Books

1. Fahlstrom PG, Gleason TJ. Introduction to UAV Systems. 4th ed. John Wiley & Sons; 2012.
2. Hassanalian M, Abdelkefi A. Design, Aerodynamics and Applications of Unmanned Aerial Vehicles. CRC Press; 2017.
3. Campion M, Ranganathan P, Faruque S. UAV Swarm Communication and Control Architectures: A Review. Journal of Unmanned Vehicle Systems. 2019.
4. Gupta L, Jain R, Vaszkun G. Survey of Important Issues in UAV Communication Networks. IEEE Communications Surveys & Tutorials. 2016.