Course Title	Sensors, Actuators, and Power Sources for IoT	**Course Number**	ECMI201
Department	ECE	**Structure (IPC)**	3-0-3
Offered to	All B.Tech. branches	**Status (Core/ Elective)**	Core
Prerequisite	Basic Electrical and Electronics Engineering	**Effective from**	
Course Aim	The aim of this course is to introduce sensor, actuators and power sources used to design IoT System.		
Course Outcomes	At the end of this course, the students will be able to 1. Understand the sensor fundamentals and characteristics. 2. Understand the suitable sensors to measure different parameter, signal conditioning and communication protocol used in the sensor. 3. Understand the different types of actuators and integration with IoT. 4. Understand the different power sources to design an IoT System.		
Contents of the course	Theory: 1. Sensor fundamentals and characteristics: Sensor Classification, Performance and Types, Static and Dynamic Characteristics Error Analysis characteristics. (5 hours) 2. Sensors to measure different parameters: Strain, Force, Torque and Pressure sensors, Position, Direction, Displacement and Level, Velocity and Acceleration sensors, Flow, Temperature and Acoustic signals, Ultra-low power Analog interfaces and ADC for IoT. (15 hours) 3. Understanding different Actuation System: Pneumatic, Hydraulic, Thermal and Electric, Micro actuators. (8 hours) 4. Case Studies: On Selection of Sensor and Actuators – Process Control, Automation and Wearable device. (7 hours) 5. Powering IoT Devices: Power Management System for IoT Nodes, Energy Harvesting, Battery Technologies for IoT. (7 hours) Practice: Integration of Sensors, Acturators, Microcontrollers, Linear Voltage Regulators, SMPS, and others with the Cloud.		
References	[1] Jacob Fraden, “Hand Book of Modern Sensors: physics, Designs and Applications”, 2015, 3rd edition, Springer, New York [2] Jon. S. Wilson, “Sensor Technology Hand Book”, 2011, 1st		

	edition, Elsevier, Netherland. [3] John G Webster, “Measurement, Instrumentation and sensor Handbook”, 2017, 2nd edition, CRC Press, Florida [4] Marc J. Madou,” Fundamentals of Microfabrication”, 2002, 2nd Edition, CRC Press, Boca Raton [5] Alioto, Massimo (Ed.) Enabling the Internet of Things, From Integrated Circuits to Integrated Systems, 2017, Springer [6] H. Janocha, “Actuators: Basics and Applications”, 2004, Springer [7] Datasheets and Application Notes of Sensors, Op-Amps, Signal Conditioning ICs [8] Recent review research articles on various topics of IoT

Course Title	Design of IoT System	**Course Number**	ECMI202
Department	ECE	**Structure (IPC)**	3-2-4
Offered to	All B.Tech. branches	**Status (Core/ Elective)**	Core
Prerequisite	Basic Electrical and Electronics Engineering	**Effective from**	
Course Aim	This course introduces the basic components of IoT and their interdependencies, deployment models, and fundamental concepts of IoT networking. This will be followed by more IoT network topics such as data and communication protocols. To have an in-depth understanding of data handling in IoT, this course has lectures on data handling, analytics, and data management for IoT devices.		
Course Outcomes	At the end of this course, the students will be able to 1. Understand the networking with IoT, its enabling technologies, and explore a young, but rich, body of exciting ideas, solutions, and paradigm shifts. 2. Understand the potential of IoT devices, support for networking according to the protocol standards, and being able to program them, would be useful for real time applications. 3. Develop the rapid prototypes of IoT based embedded systems using sensors, cloud, and open source microcontrollers such as Arduino, Raspberry Pi, BeagleBone Black, and Intel Edison/Galileo.		
Contents of the course	Theory: 1. Introduction to IoT: Definition, Trend, IoT applications, Sensing and Actuation, IoT Devices and deployment models, Power awareness of IoT, LDO in IoT. (3 hours) 2. IoT Networking: Basic IoT Components, Interdependencies, Service Oriented Architecture. (3 hours) 3. IoT Data Protocols: MQTT, SMQTT, CoAP, XMPP, AMQP. (5 hours) 4. IoT Communication Protocols and their applications: IEEE 802.15.4, ZigBee6LoWPAN, Wireless HART, Z-Wave, ISA 100, Bluetooth, and Bluetooth low energy (BLE), NFC, RFID, WiFi for IoT communications. (3 hours) 5. Data Handling, Analytics, Data management for IoT: Data cleaning and processing, Data storage models, Searching in IoT, Deep Web Semantic Sensor Web, Semantic web data management, Real-time and Big data analytics for IoT, High-dimensional data processing, Parallel and Distributed data processing. (4 hours) 6. Interoperability in IoT: Low power Interoperability for IPV6 IoT. (3 hours) 7. Cloud-Centric IoT: Architecture, Open Challenges, Energy efficiency, QoS, QoE. (3 hours) 8. Industrial IoT (IIoT): Industrial IoT and its benefits, Future of IIoT, Challenges, Examples. (3 hours)		

	9. IoT System Management and Virtualization: IoT environment management over Cloud computing framework, Fog Computing paradigm for IoT with case studies, Softwarized control and virtualization technologies for IoT network and computation resource managements. (3 hours) 10. Case Studies: Sensor body-area-network, Smart cities and Smart homes, Agriculture. (3 hours) 11. IoT Network Framework: Wireless Network Fundamental for IoT communicationtutorials with demonstrations and hands-on: 802.11 and 802.15.4 MAC Fundamentals, Management Operations, Security Overview, Network Core Protocols, Tizen Network Stack Architecture, Introduction, CAPI Architecture Overview, Sync/Async Operation Sequence, Interaction of Network Core Components, P2P Core Component Overview, OEM Layer, Supplicant Plugin Architecture overview. (6 hours) Practice: Implementation of the IoT protocols using IoT trainer kit and Cloud.
References	[1]. The Internet of Things: Enabling Technologies, Platforms, and Use Cases", by EethurumRaj and Anupama C. Raman (CRC Press). [2]. Internet of Things: A Hands-on Approach, by ArshdeepBahga and Vijay Madisetti (Universities Press). [3]. AdrianMcEwen, HakimCassimally, Designing the Internet of Things,Wiley,Nov 2013, (1st edition) [4]. Martin Charlier, Alfred Lui, Claire Rowland, Elizabeth Goodman, Ann Light, Designing Connected Products, May 2015, O'Reilly Media

Course Title	Privacy and Security in IoT	**Course Number**	ECMI301
Department	ECE	**Structure (IPC)**	3-2-4
Offered to	All B.Tech. branches	**Status (Core/ Elective)**	Core
Prerequisite	Basic Electrical and Electronics Engineering	**Effective from**	
Course Aim	To learn the security principles and methodologies for Internet of Things.		
Course Outcomes	At the end of this course, the students will be able to 1. Understand the Security requirements in IoT. 2. Understand the cryptographic fundamentals for IoT. 3. Perform the access control with authentication credentials. 4. Understand the various types Trust models and Cloud Security.		
Contents of the course	Theory: 1. Securing Internet of Things: Security Requirements in IoT Architecture - Security in Enabling Technologies - Security Concerns in IoT Applications. Security Architecture in the Internet of Things - Security Requirements in IoT - Insufficient Authentication/Authorization - Insecure Access Control - Threats to Access Control, Privacy, and Availability - Attacks Specific to IoT. Vulnerabilities – Secrecy and Secret-Key Capacity - Authentication/Authorization for Smart Devices - Transport Encryption – Attack & Fault trees (10 hours) 2. Cryptographic Fumdamentals of IoT: Cryptographic primitives and its role in IoT – Encryption and Decryption – Hashes – Digital Signatures – Random number generation – Cipher suites – key management fundamentals – cryptographic controls built into IoT messaging and communication protocols – IoT Node Authentication. (8 hours) 3. Identity and Access Management Solutions: Identity lifecycle – authentication credentials – IoT IAM infrastructure – Authorization with Publish / Subscribe schemes – access control. (5 hours) 4. Privacy Preservation and Trust Models for IoT: Concerns in data dissemination – Lightweight and robust schemes for Privacy protection – Trust and Trust models for IoT – self-organizing Things - Preventing unauthorized access. (8 hours) 5. Cloud Security for IoT: Cloud services and IoT – offerings related to IoT from cloud service providers – Cloud IoT security controls – An enterprise IoT cloud security architecture – New directions in cloud enabled IoT computing. (8 hours)		

	Practice: Implementation of Crypto Algorithms in IoT platform.
References	[1] Practical Internet of Things Security (Kindle Edition) by Brian Russell, Drew Van Duren [2] Securing the Internet of Things Elsevier [3] Security and Privacy in Internet of Things (IoTs): Models, Algorithms, and Implementations [4]. Internet of Things: A Hands-on Approach, by Arshdeep Bahga and Vijay Madisetti (Universities Press). [5]. AdrianMcEwen, HakimCassimally, Designing the Internet of Things,Wiley,Nov 2013, (1st edition)

Course Title	Electronic Devices and Circuits	**Course Number**	ECME201
Department	ECE	**Structure (IPC)**	3-4-5
Offered to	B.Tech. (AI&DS, CSE, and Mechanical)	**Status (Core/ Elective)**	Core
Prerequisite	Basic Electrical and Electronics Engineering	**Effective from**	
Course Aim	The goal of this course is to provide a good understanding and in depth knowledge of different electron devices and circuits used for various applications.		
Course Outcomes	At the end of this course, the student will be able to 1. Design various circuits using different diodes. 2. Develop and Implement various analog signal processing circuits. 3. Analyze and design various application circuits using 555 timers.		
Contents of the course	<u>1. Theory</u>: Special Purpose Electronic Devices: Zener Diode, LED, LDR, Tunnel Diode, Varactor Diode, Silicon Controlled Rectifier, BJT, JFET, MOSFET. (10 hours) <u>Practice:</u> To Study Characteristics of Electronic Devices such as diodes, BJT, JFET, MOSFET <u>2. Theory</u>: Basic of Linear Integrated Circuits: Diagram of a Typical Op-Amp, Characteristics of Ideal and Practical Op-Amp - Parameters of Op-amp, Inverting and Non-Inverting Amplifier Configurations, Summing Amplifier, Difference Amplifier, Voltage Follower, Differentiator, Integrator, Instrumentation Amplifier and Filters. (10 hours) <u>Practice</u>: To design and test different amplifier and filter circuits. <u>3. Theory</u>: Applications of Op-Amp's: Oscillators, Sine Wave, Square Wave, Triangular Wave, Saw Tooth Wave Generation, Schmitt Trigger, Analog-to-Digital, Digital-to-Analog converters. (10 hours) <u>Practice</u>: To design and test linear wave shaping circuits. <u>4. Theory</u>: Timers and Regulators: IC-555 Timer, Monostable and Astable modes of operation. (5 hours) <u>Practice</u>: To design Multi-vibrators using 555 timers. <u>5. Theory</u>: Linear Voltage Regulators, Short Circuit Protection, Basics of Switched Mode Power Supply. (5 hours) <u>Practice</u>: To design Linear Voltage Regulator.		
Textbooks	[1] J. Millman, C. C. Halkias and Satyabrata Jit, "Electronic Devices and Circuits", TMH, 3rd Ed., 2010.		

	[2] Gayakwad R.A., 'Op-amps & Linear Integrated Circuits', PHI, New Delhi, 4th Edition, 2009. [3] Roy Choudhury and S. Jain, ‘Linear Integrated Circuits’, 4th Edition, New Age International, 2010. [4] R.L. Boylestad and Louis Nashelky, Electronic Devices and Circuits, PHI, 10thEdition, 2009.
References	[1] David A. Bell, Electronic Devices and Circuits, Oxford University press, 5th Edition. [2] Sergio Franco, “Design with Operational Amplifiers and Analog Integrated Circuits”, Tata McGraw Hill, 3rd Edition, 2002.

Course Title	Signals and Systems	**Course Number**	ECME202
Department	ECE	**Structure (IPC)**	3-0-3
Offered to	B.Tech. (AI&DS, CSE, and Mechanical)	**Status (Core/ Elective)**	Core
Prerequisite	Basic Electrical and Electronics Engineering	**Effective from**	
Course Aim	The primary goal of this course is to introduce the idea of signals and systems: their analysis and characterizations. This course is a foundation for various other courses such as Analog and Digital Communications, Control theory, Image processing, Power spectral estimations, etc.		
Course Outcomes	At the end of this course, the student will be able to 1.Understand various properties of continuous time signals. 2. Analyze the frequency spectrum of continuous time signals. 3. Describe a LTI system by impulse/frequency response. 4. Analyze magnitude/phase response of various LTI systems. 5. Analyze systems commonly used in Communications, Control, and Signal Processing.		
Contents of the course	1. Introduction to Continuous/Discrete time Signals and Systems: The unit impulse and unit step functions, Continuous-time signals, Transformations of the independent variables, Exponential and Sinusoidal signals, Continuous-time systems and basic system properties. (8 hours) 2. Linear Time-invariant Discrete/Continuous Systems: Continuous-time Linear Time-invariant (LTI) system, Discrete-time LTI system, Properties of LTI systems, System representation through linear constant coefficient differential equations. (5 hours) 3. Discrete/Continuous Fourier Series Representation of Periodic Signals: Fourier series representation of continuous/discrete time periodic signals, Convergence of the Fourier series, Properties of continuous/discrete time Fourier series, Fourier series and LTI systems, Filtering, Examples of continuous-time filters described by differential equations. (7 hours) 4. Discrete/Continuous-time Fourier Transform: Representation of aperiodic signals, The Fourier transform for periodic signals, Properties of the continuous-time Fourier transform, Convolution and multiplication properties and their effect in the frequency domain, magnitude and phase response. (8 hours) 5. Laplace Transform: The Laplace transform for continuous-time signals and systems, the notion of Eigen value and Eigen functions of LTI systems, Region of convergence, System functions, Poles and zeros of system functions and signals, Properties of the Laplace		

	transform, Analysis and characterization of LTI systems using the Laplace transform, The unilateral Laplace transform. (6 hours) 6. Z-transform: Introduction of z-transform, Properties of the region of convergence of the z-transform, The inverse z-transform, Properties of the z-transform, solving the difference equations using Z-transform. (6 hours)
Textbooks	[1] A. V. Oppenheim, A. S. Willsky, and S. H. Nawab, "Signals and Systems," 2nd Edition, Prentice Hall, 2003.
References	[1] S. Haykin and B. V. Veen, "Signals and Systems" 2nd Edition, Wiley, 2007. [2] B.P. Lathi, "Principles of Linear Systems and Signals," Oxford University Press, 2nd Edition, 2009.

Course Title	Digital Logic Circuits Design	**Course Number**	ECME301
Department	ECE	**Structure (IPC)**	3-0-3
Offered to	B.Tech. (Mechanical)	**Status (Core/ Elective)**	Core
Prerequisite	Basic Electrical and Electronics Engineering	**Effective from**	
Course Aim	The goal of this course is to provide a good understanding on the design and implementation of digital circuits and systems.		
Course Outcomes	At the end of this course, the students will be able to 1. Learn digital circuits 2. Design Combinational circuits 3. Design sequential circuits 4. Formulate logic and design circuits for practical proems.		
Contents of the course	Theory: 1. Representation of Data: Introduction, Data representations, Number systems, conversions and codes. (5 hours) 2. Switching Theory: Laws and theorems of Boolean algebra, switching functions, truth table and algebraic form, realization using logic gates. (5 hours) 3. Digital Logic and Implementation: K-Maps, QM method, SOP, POS; NAND and NOR implementation, Digital Circuit Characterization. (5 hours) 4. Combinational Circuit Design: Design Procedure, Multiplexer, Decoder, Encoder, Comparator, Seven-segment display, Parity generator, Design of large circuits, Ripple Carry Adder, Carry look ahead adder, carry save adder, carry save array multiplier, Wallace tree multiplier, Restoring/Non Restoring division techniques. (10 hours) 5. Asynchronous and Synchronous Sequential Circuit Design; Design of sequential modules – SR, D, T and J-K Flip-flops, applications, Clock generation, Clock dividers, Registers, and Counters. (8 hours) 6. Design using State machines: Moore and Mealy machines,		

	Design Examples. (5 hours) 7. Issues at the Digital Circuits : Glitches, Glitch free circuit design, Static and Dynamic Hazards, Hazard resolution techniques, Race, and Cycles. (6 hours) Practice: Implementation of combinational circuits, sequential circuits, and digital arithmetic circuits using HDL and trainer board.
Textbooks	[1] C. H. Roth, Jr., "Fundamentals of Logic Design," 7th Edition, Cengage Learning, 2013. [2] S. Brown and Z. Vranesic, "Fundamentals of Digital Logic with VHDL Design," TMH, 3rd Edition.
References	[1] J. F. Wakerly, "Digital Design- Principles and Practices," 3rd Edition, Pearson [2] M. M. Mano, "Digital Design," PHI. [3] T. L. Floyd and R. P. Jain, "Digital Fundamentals," 8th Edition, Pearson. [4] Taub and Schilling, "Digital Principles and Applications," TMH. [5] V. A. Pedroni, "Digital Electronics and Design with VHDL," Elsevier. [6] R. J. Tocci, N. S.Widmer, and G. L.Moss "Digital Systems Principles and applications," 10th Edition, Pearson Prentice Hall Edition.

Course Title	Digital Signal Processing	**Course Number**	ECME302
Department	ECE	**Structure (IPC)**	3-2-4
Offered to	B.Tech. (AI&DS and CSE)	**Status (Core/ Elective)**	Core
Prerequisite	Introduction to Signals and Systems	**Effective from**	
Course Aim	The primary goal of this course is to introduce discrete-time signals and systems: their analysis and characterizations. This course is a foundation for various other courses such as Analog and Digital Filters, Digital Communications, Control theory, Image processing, Power spectral estimations, etc.		
Course Outcomes	At the end of the course, the students are expected to 1. Understand various properties of discrete-time signals 2. Analyze discrete time LTI systems, and their impulse responses 3. Synthesize discrete signals from analog signals 4. Reconstruct analog signals from discrete signals 5. Design the digital filters.		
Contents of the course	Theory: 1. Review of Discrete-time Signals and Systems: Discrete-time signals: sequences, discrete-time systems, Linear time-invariant (LTI) systems, Properties of LTI systems, Linear constant coefficient difference equations, Frequency domain representation of discrete-time signals and systems, Representation of sequences by Fourier transforms, Symmetry properties of Fourier transform, Fourier transform theorems, Discrete-time random signals. (8 hours) 2. Transform Analysis of Linear Time Invariant Systems: The frequency response of LTI systems, System functions for systems characterized by linear constant-coefficient difference equations, Frequency response of rational system functions, Relationship between magnitude and phase, All-pass systems, Minimum phase systems. (8 hours) 3. Fast Fourier Transform: Introduction of the Discrete Fourier Transform (DFT), TheFourier transform of periodic signals, Properties of DFT, Linear convolution using the DFT. Efficient computation of the DFT, The Goertzel algorithms, Radix-2 decimation-in-time and decimation-in- frequency Fast Fourier Transform algorithms. (8 hours) 4. Structures for Discrete-Time Systems: Block Diagram Representation of Linear Constant-Coefficient Difference Equations, Signal Flow Graph Representation, Direct Forms, Cascade Form. (6		

	hours) 5. Filter Design Techniques: Analog filter design, Butterworth, Chebyshev filter technique. FIR filter design using Windowing and frequency sampling techniques. IIR filter design using impulse invariance and bilinear transformation, FIR and IIR filter structures. (10 hours) Practice: Implementation of Sampling, DTFS, DTFT, DFT, FFT, FIR filter, and IIR filter in high level language.
Textbooks	[1] A.V. Oppenheim, R.W. Schafer, and J. R. Buck, “Discrete-Time Signal Processing,” Pearson Education, 3rd Edition, 2010.
References	[1] S. K. Mitra, “Digital Signal Processing: A Computer-Based Approach”, 4th Edition, Tata Mcgraw Hill Publication, 2013. [2] J. G. Proakis and D. G. Manolakis, “Digital Signal Processing: Principles, Algorithms and Applications”, Fourth edition, Pearson, 2007.