Eighth Semester ECE					
Theory					
Sl. No.	**Category**	**Subject Code**	**Subject Name**	**L-T-P**	**Credit**
1	OEC	**Open Elective-5/ MOOC Certification**			
		22EC8OE01T	Communication Engineering/ MOOC Certification	3-0-0	3
		22EC8OE02T	Electronics Design Automation/ MOOC Certification		
2	OEC	**Open Elective-6/MOOC Certification**		3-0-0	3
		22EC8OE03T	Microcontroller and Applications / MOOC Certification		
		22EC8OE04T	Environmental Monitoring Systems / MOOC Certification		
Total Credit (Theory)					
1	PSI	22EC8PS01L	Major Project/Internship	0-0-12	6
2	PSI	22EC8PS02L	Comprehensive Viva-Voce	0-0-4	2
Total Semester Credit					**14**

Open Elective Course [OEC] offered by ELC to other branch students

COURSE DESCRIPTION: Communication Engineering

Degree	B. Tech.	
Level	Graduate	
Branch	ECE (Electronics and Communication Engineering)	
Semester	8th	
Subject Name	**Communication Engineering**	
Course Type	Theory	
Course Code	22EC8OE01T	
Category	OEC	
Credit Point	3	
Time Commitment	Lecture	36 Hours
	Tutorial	08 Hours
	Practice	Nil
	Total	44 Hours
Recommended Background Knowledge	Basic electronics, Digital, Signal and Systems and Digital Signal processing.	
Subject Description	This course provides comprehensive knowledge of communication engineering, covering the design, implementation, and analysis of an automated communication system. Students will learn the signals and its spectrum, different modulation techniques.	
Objectives and Outcomes	**Objectives:** The course should enable the students to: 1. Concept of time and frequency domain analysis of signals used in communication systems. 2. Understand various analog modulation techniques and their applications in real world scenario. 3. Application of the Sampling theorem in analog-to-digital conversion process and understand the limits of practical sampling techniques. 4. various modulation techniques used for digital representation of analog signals.	

	Outcomes: Upon completion of this course, the student will be able to: 1. Analyze frequency response of signals and illustrate the concepts of random variables used in communication systems. 2. Explain the concept of continuous wave modulation techniques and evaluate in terms of power, bandwidth, etc. 3. Summarize the concept of sampling in various pulsemodulation techniques in signal transmission. 4. Explain and analyze techniques used for transmission of analog signal in digital form.	
Assessment/ Evaluation	Mid-Term Examination	30 %
	Quiz Test-1	2.5 %
	Quiz-Test-2	2.5 %
	Surprise Test	5 %
	Assignment-1	2.5 %
	Assignment-2	2.5 %
	Attendance	5 %
	End-Term Examination	50 %
Prescribed Text Book(s)	1. H. Taub, D. L Schilling, G. Saha; *Principles of Communication System*, 4th Edition; 2013, McGraw Hill, India. 2. B. P. Lathi, Zhi Ding; *Modern Digital and Analog Communication Systems*, 4th Edition; 2017, Oxford University Press.	
Reference Book(s)	1. Masoud Salehi, John G. Proakis; *Communication System Engineering*, 2nd Edition, Pearson. 2. P Ramakrishna Rao; *Analog Communication*, 1st Edition, Tata McGraw-Hill.	
Digital Learning Resources	**Course Link** https://www.nptel.ac.in/courses/117/105/117105143/ **Course Instructor** Prof. Goutam Das, Department of ECE, IIT Kharagpur	

CO's Mapping with PO's and PEO's

Course Outcomes	Course Outcome Statement	PO's / PEO's
CO1	Analyze frequency response of signals and illustrate the concepts of random variables used in communication systems.	PO1, PO6, PO7, PO9, PEO1, PEO3.
CO2	Explain the concept of continuous wave modulation techniques and evaluate in terms of power, bandwidth, etc.	PO1, PO2, PO3, PO5, PO10, PEO1, PEO2.
CO3	Summarize the concept of sampling in various pulse modulation techniques in signal transmission.	PO1, PO2, PO3, PO4, PO5, PO8, PO10, PEO1, PEO2, PEO3.
CO4	Explain and analyze techniques used for transmission of analog signal in digital form.	PO1, PO2, PO4, PO5, PO9, PO11, PEO2, PEO3.

DETAILED SYLLABUS:

Module No. 1	**Signals and Spectra and Frequency Domain Analysis of Signals and Systems**	**(6 Hours)**
Elements of communication System, Communication Channels and their Characteristics, Mathematical Models for Communication Channels. Fourier series, Fourier Transforms, Properties, Power and Energy signal.**(Ref: TB 1, Ch1)**		

Module No. 2	**Amplitude Modulation Systems**	**(10 Hours)**
Need of modulation, linear and nonlinear type of modulation, Frequency translation, Amplitude Modulation: Time and frequency analysis of DSB-C, DSB-SC, SSB and VSB Modulation. Modulators and demodulators: Square law modulator, switching modulator, square law detection and envelope detection, Concept of Frequency Division Multiplexing.		

(Ref: TB 1, Ch 2)

Module No. 3	**Angle Modulation**	**(8 Hours)**
Angle Modulation, types of angle modulation (FM and PM), Comparison: modulation index, sidebands, power and phasor diagram, Tone Modulated FM Signal, Arbitrary Modulated FM signal, Concept of narrowband and wideband FM(PM), FM Modulators: Direct & Indirect methods, Demodulators: limiter and discriminator. **(Ref: TB 1, Ch 3)** Radio Transmitter and Receiver: FM and AM Superheterodyne receiver, image frequency and its rejection, FM stereo broadcasting.		

Module No. 4	**Digital Transmission of Analog Signal and Pulse Modulation**	**(8 Hours)**
Concept of sampling, types of sampling, Time and frequency analysis of Sampling Theorem **(Ref: TB 2, Ch 5/TB1. Ch 4)** Pulse Amplitude Modulation: bandwidth, generation and recovery, Time division multiplexing of PAM signals, Pulse Width Modulation and Pulse Position Modulation. **(Ref: TB 1, Ch4)**		

Module No. 5	**Digital Representation of Analog Signal**	**(8 Hours)**
Quantization of signals, Quantization error, Pulse Code Modulation, Companding, Line coding techniques, Delta Modulation, Adaptive delta modulation. **(Ref: TB 1, Ch4)**		

COURSE DESCRIPTION: Electronics Design and Automation

Degree	B. Tech.
Level	Graduate
Branch	ECE (Electronics and Communication Engineering)
Semester	8th
Subject Name	**Electronics Design and Automation**

<table>
<tr><td>Course Type</td><td colspan="2">Theory</td></tr>
<tr><td>Course Code</td><td colspan="2">22EC8OE02T</td></tr>
<tr><td>Category</td><td colspan="2">OEC</td></tr>
<tr><td>Credit Point</td><td colspan="2">3</td></tr>
<tr><td rowspan="4">Time Commitment</td><td>Lecture</td><td>36 Hours</td></tr>
<tr><td>Tutorial</td><td>08 Hours</td></tr>
<tr><td>Practice</td><td>Nil</td></tr>
<tr><td>Total</td><td>44 Hours</td></tr>
<tr><td>Recommended Background Knowledge</td><td colspan="2">Students should have a basic understanding of digital electronics, including logic gates, flip-flops, and combinational/sequential circuits, along with fundamental knowledge of electronic devices and CMOS circuits. Familiarity with Verilog or VHDL, basic programming skills, and working knowledge of the UNIX/Linux environment is also recommended.</td></tr>
<tr><td>Subject Description</td><td colspan="2">This course provides an in-depth introduction to VLSI CAD tools used in front-end and back-end design processes. It covers layout generation, design rule checks, circuit simulation using Cadence tools, and system-level modeling using hardware description languages like Verilog and System Verilog in a UNIX-based environment.</td></tr>
<tr><td rowspan="2">Objectives and Outcomes</td><td colspan="2">Objectives:

The course should enable the students to:

1) Learn and gain hands-on experience with Front-end and Back-end VLSI CAD tools.
2) Understand the basics of layout generation, design rule checking (DRC), and the UNIX environment commonly used in CAD tools.
3) To explore the role of Cadence in circuit simulation and perform various simulation analyses, such as DC, AC, and transient analysis.
4) Learn how to design hardware/software system models using appropriate system-level modeling languages, such as Verilog and System Verilog.</td></tr>
<tr><td colspan="2">Outcomes:
Upon completion of this course, the student will be able to:</td></tr>
</table>

<table>
<tr><td></td><td colspan="2">1) Understand layout generation techniques, design rule checks, and the use of UNIX commands and scripting in VLSI design workflows.
2) Perform circuit simulations using SPICE and Cadence tools for DC, AC, and transient analysis.
3) Design and synthesize combinational and sequential circuits using Verilog HDL.
4) Develop and verify hardware models using SystemVerilog constructs and integrate them with testbenches for simulation.</td></tr>
<tr><td rowspan="9">Assessment/ Evaluation</td><td>Mid-Term Examination</td><td>30 %</td></tr>
<tr><td>Quiz Test-1</td><td>2.5 %</td></tr>
<tr><td>Quiz-Test-2</td><td>2.5 %</td></tr>
<tr><td>Surprise Test</td><td>5 %</td></tr>
<tr><td>Assignment-1</td><td>2.5 %</td></tr>
<tr><td>Assignment-2</td><td>2.5 %</td></tr>
<tr><td>Attendance</td><td>5 %</td></tr>
<tr><td>End-Term Examination</td><td>50 %</td></tr>
<tr><td>Prescribed Text Book(s)</td><td colspan="2">1. M.H. Rashid, “Spice for Circuits and Electronics using Pspice”, 2nd Edition, PHI.
2. Samir Palnitkar “Verilog HDL: A Guide to Digital Design and Synthesis”, Prentice Hall.
3. Chris Spears, “ System Verilog for Verification”, Springer, 2nd Edition</td></tr>
<tr><td>Reference Book(s)</td><td colspan="2">1. H. Gerez, “Algorithms for VLSI Design Automation”, John Wiley, 1999.
2. Z. Dr Mark, “Digital System Design with System Verilog”, Pearson, 2010.

3. S. Sutherland, S. Davidmann & P. Flake, “System Verilog for Design”, 2nd Edition, Springer, 2006.

4. Essential Electronics design Automation (EDA)- Mark D. Birnbaum, Prentice Hall,2004

5.M.J.S.Smith, “Application Specific Integrated Circuits”, Pearson, 2008

6.Electronics Design Automation: Synthesis, verification & Test (System on Silicon)-</td></tr>
</table>

	LaungTerng Wang, Morgan Kaufmann,2009		
Digital Learning Resources	Course Name	Electronic Design and Automation	
	Course Link	NPTEL : Computer Science and Engineering -Electronic Design and Automationhttps://nptel.ac.in/courses/106/105/106105083/	
	Course Instructor	Prof. I. Sengupta, IIT Kharagpur	

CO's Mapping with PO's and PEO's

Course Outcomes	Course Outcome Statement	PO's / PEO's
CO1	Understand layout generation techniques, design rule checks, and the use of UNIX commands and scripting in VLSI design workflows	PO1, PO2, PO4, PO5, PO7, PO10, PO11, PO12, PEO1, PEO2.
CO2	Perform circuit simulations using SPICE and Cadence tools for DC, AC, and transient analysis.	PO1, PO2, PO3, PO4, PO7, PO8, PO10, PO12, PEO1, PEO2.
CO3	Design and synthesize combinational and sequential circuits using Verilog HDL.	PO1, PO2, PO4, PO5, PO8, PO10, PO11, PEO1, PEO2.
CO4	Develop and verify hardware models using System Verilog constructs and integrate them with test benches for simulation.	PO1, PO2, PO3, PO4, PO7, PO8, PO10, PO11, PO12, PEO1, PEO2.

DETAILED SYLLABUS:

Module No. 1	Layout generation	**(4 Hours)**
Design checking rules, Lamda, beta rule, Introduction to UNIX commands Handling directories, Working on Vi editor, Basic Shell Programming.		

Module No. 2	Circuit simulation using Spice	(6 Hours)
Circuit description, AC, DC and transient analysis. Advanced spice commands and analysis. Introduction to CADENCE, Use of CADENCE, Basic modeling using CADENCE, Layout generation using CADENCE.		

Module No. 3	Modeling sequential circuits	(10 Hours)
Latches and Flip-flops, counters, mealy and Moore FSM, shifters, sequential adders, multipliers and dividers. Blocking and non-blocking statements, Static timing analysis.		

Module No. 4	System Verilog	(10 Hours)
Introduction, Design hierarchy, Data types: Built-in data types, Fixed-size arrays, Dynamic arrays, Queues, Associative arrays, Linked lists, Array methods, Choosing a storage type, Creating new types with typedef, Creating user-defined structures, Type conversion, Enumerated types, Constants strings, Expression width.		

Module No. 5	System Verilog Procedural statements and routines	(10 Hours)
Procedural statements, tasks, functions and void functions, Routine arguments, Returning from a routine, Local data storage, Time values Connecting the test bench and design: Separating the test bench and design, Interface constructs		

COURSE DESCRIPTION: Microcontroller and Applications

Degree	B. Tech.	
Level	Graduate	
Branch	ECE (Electronics and Communication Engineering)	
Semester	8th	
Subject Name	**Microcontroller and Applications**	
Course Type	Theory	
Course Code	22EC8OE03T	
Category	OEC	
Credit Point	3	
Time Commitment	Lecture	36 Hours
	Tutorial	08 Hours
	Practice	Nil
	Total	44 Hours
Recommended Background Knowledge	Basic Electronics and Digital Electronics.	
Subject Description	This course provides comprehensive knowledge of Microcontroller and Applications, covering the Architecture of 8051 and its I/O port, Timer and counter and Interrupt, MSP430 Architecture, MSP430 Clock System, Interrupts and Operating Modes and MSP430Analog and Digital Input-Output. Students will learn the details of different microcontrollers and their applications.	
Objectives and Outcomes	**Objectives:** The course should enable the students to: 1. To introduce the architectures of microcontrollers and its role in embedded system 2. To familiarize the students with architecture and assembly language programming in 8051 microcontroller 3. To design the interfacing of peripherals interfacing with the 8051	

<table>
<tr><td></td><td colspan="2">microcontroller
4. To introduce industry standard microcontroller and its application</td></tr>
<tr><td></td><td colspan="2">Outcomes:
Upon completion of this course, the student will be able to:
1. Outline comprehensive knowledge about architecture and assembly language programming.
2. Examine the inbuilt resources of 8051 Microcontroller
3. Describe the architectural features and instruction set of MSP430.
4. Investigate the design aspect and development of interfacing I/O devices with MSP430 microcontroller.</td></tr>
<tr><td rowspan="9">Assessment/ Evaluation</td><td>Mid-Term Examination</td><td>30 %</td></tr>
<tr><td>Quiz Test-1</td><td>2.5 %</td></tr>
<tr><td>Quiz-Test-2</td><td>2.5 %</td></tr>
<tr><td>Surprise Test</td><td>5 %</td></tr>
<tr><td>Assignment-1</td><td>2.5 %</td></tr>
<tr><td>Assignment-2</td><td>2.5 %</td></tr>
<tr><td>Attendance</td><td>5 %</td></tr>
<tr><td>End-Term Examination</td><td>50 %</td></tr>
<tr><td>Prescribed Text Book(s)</td><td colspan="2">1. The 8051 Microcontroller and Embedded Systems using assembly and C by M.A. Mazidi, J.G. Mazidi, Pearson.
2. MSP430 microcontroller basics by John H. Davies, Newnes Publication ISBN-13: 978-0-7506-8276-3</td></tr>
<tr><td>Reference Book(s)</td><td colspan="2">1. Microcontrollers [Theory and applications] by Ajay V Deshmukh; McGraw Hill publication.
2. Introduction to Embedded Systems: Using Microcontrollers and the MSP430 by Manuel Jimenez, Rogelio Palomera, Isidoro Couvertier by Springer-Verlog New York, ISBN13: 978-1-4614-3143-5
3. Chris Nagy, Embedded Systems Design using TI MSP430 Series, Newnes Publications, Elsevier, 2003.
4. User Guide from Texas Instruments.</td></tr>
<tr><td>Digital Learning Resources</td><td colspan="2">Course Link
https://nptel.ac.in/courses/108105102</td></tr>
</table>

	Course Instructor Prof. Santanu Chattopadhyay, Department of ECE, IIT Kharagpur

CO's Mapping with PO's and PEO's

Course Outcomes	Course Outcome Statement	PO's / PEO's
CO1	Outline comprehensive knowledge about architecture and assembly language programming.	PO1, PO6, PO7, PO9, PEO1, PEO3.
CO2	Examine the inbuilt resources of 8051 Microcontroller.	PO1, PO2, PO3, PO5, PO10, PEO1, PEO2.
CO3	Describe the architectural features and instruction set of MSP430.	PO1, PO2, PO3, PO4, PO5, PO8, PO10, PEO1, PEO2, PEO3.
CO4	Investigate the design aspect and development of interfacing I/O devices with MSP430 microcontroller.	PO1, PO2, PO4, PO5, PO9, PO11, PEO2, PEO3.

DETAILED SYLLABUS:

Module No. 1	**8051 Architecture**	**(8 Hours)**
Harvard & Von Neumann architecture, RISC & CISC comparison and its features Role of microcontroller in embedded System. Limitation of 8 bit microcontrollers. 8051 Architecture, pin and signals, Register organization, memory organization (internal/external), addressing mode, instruction set, programming examples.		

Module No. 2	**8051 I/O port, Timer and counter and Interrupt**	**(8 Hours)**

8051 I/O port programming, 8051 Timers and Counters – Timer counter registers and modes, programming timers using different timer modes, 8051 interrupts, Programming timer interrupt, external hardware, serial communication interrupt, Interrupt priority and Interrupt programming.

Module No. 3	**MSP430 Architecture**	**(10 Hours)**
Introduction –Where does the MSP430 fit, The outside view, The inside view-Functional block diagram, Memory, Central Processing Unit, Memory Mapped Input and Output, Clock Generator, Resets, MSP430 family. Addressing Modes, Instruction set.		

Module No. 4	**MSP430Clock System, Interrupts and Operating Modes**	**(10 Hours)**
Clock System, Interrupts, What happens when an interrupted is requested, Interrupt Service Routines, Low Power Modes of Operation, Watchdog Timer, Basic Timer1, Real Time Clock, Timer-A: Timer Block, Capture/Compare Channels, Interrupts from Timer-A.		

Module No. 5	**MSP430Analog and Digital Input-Output**	**(8 Hours)**
Comparator-A, ADC10, ADC12, Sigma-Delta ADC, Internal Operational Amplifiers, DAC, Parallel Ports, Lighting LEDs, Flashing LEDs, Read Input from a Switch, Toggle the LED state by pressing the push button, LCD interfacing.		

COURSE DESCRIPTION: Environmental Monitoring Systems

Degree	B. Tech.	
Level	Graduate	
Branch	ECE (Electronics and Communication Engineering)	
Semester	8th	
Subject Name	**Environmental Monitoring Systems**	
Course Type	Theory	
Course Code	22EC8OE04T	
Category	OEC	
Credit Point	3	
Time Commitment	Lecture	36 Hours
	Tutorial	08 Hours
	Practice	Nil
	Total	44 Hours
Recommended Background Knowledge	Basic electronics, microprocessors, programming concepts, data structures, and fundamental knowledge of environmental science principles.	
Subject Description	This course provides comprehensive knowledge of environmental monitoring systems, covering the design, implementation, and analysis of automated monitoring solutions for air, water, soil, and noise pollution. Students will learn sensor technologies, IoT integration, data processing techniques, and real-world applications in environmental compliance and management.	
Objectives and Outcomes	**Objectives:** The course should enable the students to: 5) Understand environmental monitoring principles and global standards 6) Learn sensor technologies and IoT integration for monitoring systems 7) Develop data processing and analysis skills for environmental applications 8) Design complete monitoring systems for real-world applications	

<table>
<tr><td></td><td colspan="2">Outcomes:
Upon completion of this course, the student will be able to:

5) Apply environmental monitoring principles and global standards for pollution assessment and compliance.
6) Select, calibrate and implement appropriate sensors for accurate environmental data collection applications.
7) Design IoT-based monitoring systems using microcontrollers, wireless protocols and cloud platforms effectively.
8) Analyze environmental data using processing techniques and machine learning for predictive modeling.</td></tr>
<tr><td rowspan="9">Assessment/ Evaluation</td><td>Mid-Term Examination</td><td>30 %</td></tr>
<tr><td>Quiz Test-1</td><td>2.5 %</td></tr>
<tr><td>Quiz-Test-2</td><td>2.5 %</td></tr>
<tr><td>Surprise Test</td><td>5 %</td></tr>
<tr><td>Assignment-1</td><td>2.5 %</td></tr>
<tr><td>Assignment-2</td><td>2.5 %</td></tr>
<tr><td>Attendance</td><td>5 %</td></tr>
<tr><td>End-Term Examination</td><td>50 %</td></tr>
<tr><td>Prescribed Text Book(s)</td><td colspan="2">1. Environmental Monitoring with Arduino" by Emily Gertz and Patrick Di Justo, O'Reilly Media, 2012
2. Introduction to Environmental Engineering and Science" by Gilbert M. Masters and Wendell P. Ela, Pearson, 3rd Edition, 2014.
3. IoT-Based Environmental Monitoring" by V.K. Sharma, Springer, 2020.</td></tr>
<tr><td>Reference Book(s)</td><td colspan="2">1. Environmental Monitoring Handbook" by Frank R. Burden, McGraw-Hill, 2002.
2. Sensors for Environmental Monitoring" by R.K. Mishra, CRC Press, 2019.
3. Internet of Things: Principles and Paradigms" by Rajkumar Buyya and Amir Vahid Dastjerdi , Morgan Kaufmann, 2016.</td></tr>
<tr><td>Digital Learning Resources</td><td colspan="2">Online Platforms:

• EPA Environmental Monitoring: www.epa.gov/monitoring
• CPCB Air Quality Data: www.cpcb.nic.in</td></tr>
</table>

	• WHO Air Quality Guidelines: www.who.int/health-topics/air-pollution • Arduino Project Hub: create.arduino.cc • Thing Speak IoT Platform: thingspeak.com **Video Learning:** • Coursera: Environmental Engineering courses • edX: IoT and Data Analytics specializations • YouTube: Arduino environmental projects tutorials • NPTEL: Environmental Science and Engineering lectures

CO's Mapping with PO's and PEO's

Course Outcomes	Course Outcome Statement	PO's / PEO's
CO1	Apply environmental monitoring principles and global standards for pollution assessment and compliance.	PO1, PO6, PO7, PO9, PEO1, PEO3.
CO2	Select, calibrate and implement appropriate sensors for accurate environmental data collection applications.	PO1, PO2, PO3, PO5, PO10, PEO1, PEO2.
CO3	Design IoT-based monitoring systems using microcontrollers, wireless protocols and cloud platforms effectively.	PO1, PO2, PO#, PO4, PO5, PO8, PO10, PEO1, PEO2, PEO3.
CO4	Analyze environmental data using processing techniques and machine learning for predictive modeling.	PO1, PO2, PO4, PO5, PO9, PO11, PEO2, PEO3.

DETAILED SYLLABUS:

Module No. 1	Introduction to Environmental Monitoring	**(6 Hrs.)**
Importance of environmental monitoring: Air, water, soil, noise pollution. Key parameters: Temperature, humidity, pH, DO, PM2.5/PM10, CO2, VOCs. Types of monitoring systems: Manual, automated, real-time, remote. Global standards: WHO, CPCB, EPA, ISO guidelines. Applications: Urban planning, industrial compliance, climate change		

Module No. 2	Sensors and Instrumentation	**(10 Hrs.)**
Types of environmental sensors: Chemical, physical, and biological sensors. Working principles: Electrochemical, optical, thermal, and semiconductor-based sensors. Sensor selection criteria: Sensitivity, accuracy, range, and cost. Calibration and maintenance of sensors. Case studies: Sensors for air quality (e.g., MQ series), water quality (e.g., pH probes), and weather monitoring.		

Module No. 3	Data Acquisition and IoT Integration	**(10Hrs.)**
Data acquisition systems (DAS): Analog-to-digital conversion, signal conditioning. Microcontrollers and platforms: Adriano, Raspberry Pi, ESP32 for environmental monitoring. IoT for environmental monitoring: Architecture, protocols (MQTT, HTTP), and cloud platforms (Thing Speak, AWS IoT).Wireless communication: Wi-Fi, Bluetooth, LoRa, Zigbee, and GSM for remote monitoring. Power management: Solar-powered and battery-operated systems.		

Module No. 4	Data Processing and Analytics	**(10 Hrs.)**
Data preprocessing: Noise filtering, outlier detection, and data normalization. Data visualization: Dashboards, graphs, and GIS-based mapping. Machine learning for environmental data: Predictive models for pollution trends. Real-time analytics and alert systems for environmental thresholds.		

Module No. 5	System Design and Applications	**(10 Hrs.)**
Design of environmental monitoring systems: From sensor selection to data transmission. Case studies: Air quality monitoring in urban areas. Water quality monitoring for rivers and lakes. Soil monitoring for agriculture. Noise pollution mapping in cities. Challenges: Scalability, cost, and data security. Emerging trends: Drones, satellite-based monitoring, and AI-driven systems.		