HONOURS

ELECTRONICS AND COMMUNICATION ENGINEERING

B.Tech.

22EC961	-	ADHOC Sensor Networks
22EC962	-	Cloud Computing for IoT Systems
22EC963	-	Embedded System Design Using FPGA
22EC964	-	Embedded Systems
22EC965	-	Introduction to Internet Of Things
22EC966	-	IoT Architecture
22EC967	-	IoT Design
22EC968	-	IoT Security
22EC969	-	Sensors and Actuators for IoT

COURSE CONTENTS

I SEM & II SEM

22EC961 ADHOC SENSOR NETWORKS

Source: https://www.brainkart.com/subject/Ad-hoc-and-Wireless-Sensor-Networks_363/

Hours Per Week :

L	T	P	C
3	0	2	4

PREREQUISITE KNOWLEDGE: Basics of computer networks.

COURSE DESCRIPTION AND OBJECTIVES:

This course is aimed at offering fundamental concepts of wireless ad-hoc networks and wireless sensor networks. Explore the various routing protocols and their importance for designing of energy efficient and reliable wireless networks.

MODULE –1

UNIT-1 **12L+0T+8P=20 Hours**

ADHOC NETWORKS:

Introduction to Ad Hoc Networks - Characteristics of MANETs, Applications of MANETs and Challenges of MANETs. Routing in MANETs - Criteria for classification, Taxonomy of MANET routing algorithms, Topology based routing algorithms-Proactive: DSDV; Reactive: DSR, AODV; Hybrid: ZRP; Position-based routing algorithms-Location Services-DREAM.

UNIT-2 **12L+0T+8P=20 Hours**

DATA TRANSMISSION SCHEMES:

Broadcast Storm Problem, Rebroadcasting Schemes-Simple-flooding, Probability-based Methods, Area-based Methods, Neighbor Knowledge-based: SBA, Multipoint Relaying, AHBP. Multicasting: Tree-based: AMRIS, MAODV; Mesh-based: ODMRP, CAMP; Hybrid: AM Route, MCEDAR.

MODULE-2

UNIT-1 **12L+0T+8P=20 Hours**

SENSOR NETWORKS- INTRODUCTION & ARCHITECTURES:

Challenges for Wireless Sensor Networks, Enabling Technologies for Wireless Sensor Networks, WSN application examples, Single Node Architecture – Hardware Components, Energy Consumption of Sensor Nodes, Network Architecture – Sensor Network Scenarios, Transceiver Design Considerations, Optimization Goals and Figures of Merit.

UNIT-2 **12L+0T+8P=20 Hours**

SENSOR NETWORK PLATFORMS AND TOOLS:

Sensor Node Hardware – Berkeley Motes, Programming Challenges, Node-level software platforms – TinyOS, nesC, CONTIKIOS, Node-level Simulators – NS2 and its extension to sensor networks, COOJA, TOSSIM, Programming beyond individual nodes – State centric programming.

PRACTICES:

Experiments to be carried out in any network simulator like NETSIM, NS2 and OMNET++ etc.

- Examine the various path loss models available for wireless networks
- Identify the various reasons for hidden node terminal problem in wireless ad-hoc networks.
- Create a scenario where both ad-hoc and wireless sensor network are available and examine the interference problem.

SKILLS:

- ✓ *Identify the various issues and their solutions in for designing wireless networks*
- ✓ *Implement routing algorithms for ad-hoc and sensor networks.*
- ✓ *Design an energy efficient wireless sensor network for various applications.*

- Analyze how the application-level throughput changes as a function of nominal bitrate in an 802.11g network.
- Simulate the multiple wireless scenarios for throughput performance.
- Analyze performance of the MANET routing protocols in various parameters like end-to-end delay, bit error rate and throughput.
- Design a wireless sensor network and observe how the power consumption consumed for the network.
- Examine the importance of channel accessing mechanism helped for getting high throughput in wireless networks.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Realize concepts, network architectures and applications of ad hoc and wireless sensor networks	Create	1	1, 2, 4, 9, 10, 11, 12
2	Analyze the protocol design issues of ad hoc and sensor networks	Analyze	1	1, 2, 3, 4, 9, 10, 11, 12
3	Design routing protocols for ad hoc systems.	Create	2	1, 2, 3, 4, 9, 10, 11, 12
4	Evaluate the QoS related performance measurements of ad hoc and sensor networks	Evaluate	2	1, 2, 3, 4, 9, 10, 11, 12

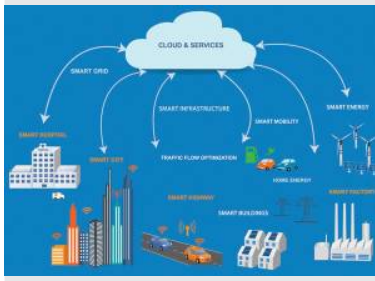
TEXT BOOKS:

1. Carlos Corderio Dharma P. Aggarwal, “Ad-Hoc and Sensor Networks – Theory and Applications”, World Scientific Publications, March 2011.
2. Feng Zhao and Leonides Guibas, “Wireless Sensor Networks”, Elsevier Publication–2002

REFERENCES BOOKS:

1. C. Siva Ram Murthy and B. S. Manoj, “Ad Hoc Wireless Networks Architectures and Protocols”, Prentice Hall, PTR, 2004.
2. Kazem sohraby, Daniel Minoli and Taieb Znati, “Wireless Sensor Networks: Technology, Protocols and Application” John Wiley, 2007.
3. C.K Toh, “Ad-Hoc Mobile Wireless Networks: Protocols and Systems” 1st edition, Pearson, 2007.

22EC962 CLOUD COMPUTING FOR IOT SYSTEMS



Source: https://iotdesignpro.com/articles/iot-and-cloud-computing

Hours Per Week :

L	T	P	C
3	0	2	4

PREREQUISITE KNOWLEDGE: Introduction to IoT.

COURSE DESCRIPTION AND OBJECTIVES:

This course offers skills on IoT edge usage and networking techniques of cloud. The objective of the course is to enable the students to design and develop cloud services for IoT systems.

MODULE - 1

UNIT-1 **12L+0T+8P=20 Hours**

FUNDAMENTALS OF IOT SYSTEM:

IoT system architecture and design approaches, IoT standards, Ubiquitous computing and internet of things, IoT communication requirements - IoT network design fundamentals.

UNIT-2 **12L+0T+8P=20 Hours**

NETWORKING TO CLOUD:

Networking - SSH, Sockets, Network libraries, and web services, Retrieving data from real-world sensors, Working with cloud – Publishing data, Setting up IoT analytics at cloud.

PRACTICES:

- Sending an SMS and Email using cloud services.
- Interface any sensor and upload the data to Thing speak cloud.
- Counting the number of people who entered the room and store the data in the cloud using SSH.
- Door lock system using Blynk cloud services.

MODULE-2

UNIT-1 **12L+0T+8P=20 Hours**

IOT EDGE TO CLOUD PROTOCOLS:

MQTT, MQTT – SN, CoAP, HTTP, RestFul API, AMQP, Significance of gateway design, Characteristics, Protocol bridging, Implementations, Edge analytics at devices and gateways.

UNIT-2 **12L+0T+8P=20 Hours**

DATA ANALYTICS IN IOT:

Overview of existing cloud platforms-Azure/Watson/AWS, Data ingestion and complex event processing, IoT for predictive analytics and maintenance, Smart medical data sensing, and applications in health care.

PRACTICES:

- Make Raspberry pi as MQTT broker and control the ESP8266 NodeMCU as publisher and
- subscriber.
- Setting up Raspberry Pi server and writing data into it using Django.
- Image capturing and updating to the cloud using Raspberry pi.
- Live video streaming using cloud services.

SKILLS:

- ✓ *Use various sensors and actuators for IoT applications.*
- ✓ *Interface programming on I/O devices.*
- ✓ *Develop applications for the Internet of things.*

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Classify different components of an IoT system and their purpose.	Apply	1	1, 2,3
2	Able to identify appropriate protocols to interpret the data from an IoT system.	Apply	1	1, 2,3,5,12
3	Able to implement various networking protocols for IoT applications.	Apply	1	1, 2, 3, 5,12
4	Explore edge and cloud computing platforms for IoT.	Apply	2	1, 2
5	Evaluate various data analytics tools and machine learning algorithms.	Apply	2	1, 2, 3, 5

TEXT BOOKS:

1. Perry Lea, “Internet of Things for Architects”, 1st edition, Packt Publishing, 2018.
2. Subhas Chandra Mukhopadhyay, “Internet of Things Challenges and opportunities”, Springer, 2015.

REFERENCE BOOKS:

1. Adrian McEwen, “Designing the Internet of Things”, Wiley Publishers, 2013,
2. Samuel Greengard, “The Internet of Things (Essential Knowledge)”, MIT Press, 2015.
3. Timothy Chou,. Precision: Principles, Practices and Solutions for the Internet of Things, Cloudbook Inc., USA. April-13 2020.

22EC963 EMBEDDED SYSTEM DESIGN USING FPGA

Source: https://synective.se/services/machine-learning/

Hours Per Week :

L	T	P	C
3	0	2	4

PREREQUISITE KNOWLEDGE: Computer Architecture and Organization, Microprocessors and Microcontrollers.

COURSE DESCRIPTION AND OBJECTIVES:

This course covers the design and analysis of digital circuits with Verilog HDL. The primary goal is to provide basic understanding of system design. The course enables students to apply their knowledge for the design of digital hardware systems with help of FPGA tools like Digital system design using Verilog HDL, know FPGA architecture, interconnect and technologies, understand and implement embedded system on FPGA.

MODULE - I

UNIT-I **12L+0T+8P=20 Hours**

INTRODUCTION TO FPGA ARCHITECTURES AND XILINX VIVADO:

Introducing FPGAs: Exploring the Xilinx Artix-7 and 7 series devices, Combinational logic blocks, Storage, Clocking, I/Os, DSP48E1, ASMBL architecture.

Introducing Vivado: Directory structure.

Gate-level Combinational circuit
general description, basic lexical elements, data types, four-value system, data type groups, number representation, operators, program skeleton, port declaration, program body, signal declaration, structural description, testbench.

UNIT-II **12L+0T+8P=20 Hours**

RT-LEVEL COMBINATIONAL CIRCUIT:

Introduction, operators, always block for a combinational circuit, If statement, case statement, coding guidelines for an always block, parameter, constant, BCD incrementor.

PRACTICES:

- Setup and test the available FPGA board using the appropriate software tool.
- Design and test up and down counters
- Design and test a Binary Coded Decimal Adder.
- Design a Sequence Detector using Mealy Machine
- Design a Sequence Detector using Moore Machine

MODULE-2

UNIT-I **12L+0T+8P=20 Hours**

REGULAR SEQUENTIAL CIRCUIT:

Introduction, HDL code of the FF and register, simple design examples, test bench for sequential circuits, square wave generator, PWM and LED dimmer.

SKILLS:

- ✓ *Identify various cmos logics to design combinational circuits.*
- ✓ *Design CMOS based sequential circuits.*
- ✓ *Analyze the timing constraints in the VLSI designs.*

UNIT-II **12L+0T+8P=20 Hours**

FSM:

Introduction- Mealy and Moore outputs, FSM Representation, FSM code development, Design examples - Rising-edge detector, Debouncing circuit

UART:

UART receiving subsystem, UART transmitting subsystem, Overall UART system, Customizing a UART

PRACTICES:

- Generate a square wave signal with FPGA.
- Generate a sinusoidal signal with FPGA.
- Send a series of characters to PC through UART
- Interface a stepper motor FPGA

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Design and optimize complex combinational and sequential digital circuits.	Apply	1,2	1, 2, 3, 4, 9, 10, 11, 12
2	Model and implement Combinational and sequential digital circuits by Verilog HDL.	Create	1,2	1, 2, 3, 4, 9, 10, 11, 12
3	Design and model digital circuits with Verilog HDL at behavioural, structural, and RTL Levels.	Create	1,2	1, 2, 3, 4, 9, 10, 11, 12
4	Develop test benches to simulate combinational and sequential circuits.	Create	1,2	1, 2, 3, 4, 9, 10, 11, 12

TEXT BOOKS:

1. FPGA Programming for beginners by Fank Bruno, Packt Publishing Limited, 2021, ISBN 978-1-78980-541-3.
2. FPGA Prototyping By Verilog Examples, by Pong P. Chu, A JOHN WILEY & SONS, INC., PUBLICATION, 2008

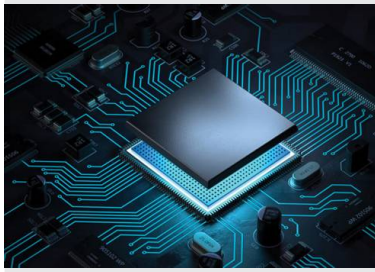
REFERENCE BOOKS:

1. A Verilog HDL primer by J. Bhaskar, Star Galaxy Pub., 2004.
2. Verilog HDL Design Examples by Joseph Cavanagh, CRC Press, 2017.
3. VHDL and FPLDs, by Zoran Salcic, Kluwer,1998.
4. Computers as Components, Principles of Embedded Computing System Design, by Wayne Wolf, Morgan Kauffman, 2001.
5. A VHDL Primer, by Jayaram Bhasker. Prentice Hall, 1998.
6. HDL Chip Design, by Douglas J. Smith, 1999.
7. VHDL Analysis and Modeling of Digital Systems, by Z. Navabi, McGraw-Hill, 1993.

WEB REFERENCES

1. http://www.ece.rutgers.edu/node/1528
2. http://www.ece.iastate.edu/~morris/388/syllabus_388x.html

22EC964 EMBEDDED SYSTEMS



Source: https://www.itpro.com/hardware/30317/what-is-an-embedded-system

Hours Per Week :

L	T	P	C
3	0	2	4

PREREQUISITE KNOWLEDGE: Computer Architecture and Organization, Microprocessors and Microcontrollers.

COURSE DESCRIPTION AND OBJECTIVES:

The course objective is to study the applications, categories, hardware and software architectures, memory, testing tools in embedded systems, Firmware, Embedded C, operating system functions and various kernel objects and RTOS.

MODULE-1

UNIT-1 **12L+0T+8P=20 Hours**

INTRODUCTION:

Basic concepts, Applications and Categories of embedded systems, Hardware architecture, Software architecture of Embedded Systems, Process of generating executable images, Development/testing tools.

UNIT-2 **12L+0T+8P=20 Hours**

PROGRAMMING:

Comparison of Assembly and C languages, C and Embedded C.

Programming in C: Arrays, Structures, Loops and Decisions, Pointers, Functions,

Embedded C: Header files for Project and Header files for Port.

PRACTICES:

- Programming with Embedded C using any compiler.
- Demonstration/Practical session for creation of header files.
- Program to create loops in Embedded C
- Program to implement decisions in Embedded C
- Develop program to implement interrupt function

MODULE-2

UNIT-1 **12L+0T+8P=20 Hours**

OPERATING SYSTEMS:

Introduction to Operating Systems, Process and threads, Scheduling, Non-preemptive and Preemptive scheduling, Real Time Scheduling.

UNIT-2 **12L+0T+8P=20 Hours**

REAL TIME OPERATING SYSTEMS:

Introduction to Real Time Operating Systems, Shared Data Problem, Semaphores, Priority inversion problem, Inter process/task communication techniques.

SKILLS:

- ✓ *Choose component for Embedded System.*
- ✓ *Understand operating system concepts. Understand .*

PRACTICES:

- Create and schedule a process/task
- Demonstrate shared data problem
- Create and use semaphores
- Find schedulability using Gantt charts
- Implement IPC techniques

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Identify the components of embedded systems and differentiate various embedded systems	Apply	1	1, 2, 3, 4, 9, 10, 11, 12
2	Design embedded systems using standard procedure	Create	1	1, 2, 3, 4, 9, 10, 11, 12
3	Choose necessary component and buses for the embedded system	Apply	2	1, 2, 3, 4, 9, 10, 11, 12
4	Apply the knowledge of operating system functions and various kernel objects	Apply	2	1, 2, 3, 4, 9, 10, 11, 12

TEXT BOOKS:

1. Raj Kamal, “Embedded Systems Architecture, Programming and Design”, 3rd edition, Mc Graw Hill, 2017.
2. Embedded Systems An Integrated Approach, Lyla B. Das, Pearson Education, 2013

REFERENCE BOOKS:

1. Marilyn wolf, “Computers as Components: Principles of Embedded Computer systems design”, 4th edition, Morgan Kaufmann Publishers, 2017.
2. Dr. K.V.K.K. Prasad, “Embedded Real time Systems”, Black book, Dreamtech Press, 2003.
3. Daniel W. Lewis, “Fundamentals of Embedded Software: Where C and Assembly Meet”, 1st edition, Pearson, 2001.
4. John Catsoulis, “Designing Embedded Hardware”, 2nd Edition, O’Reilly Media, Inc., 2005.
5. “Getting Started with Arduino: The Open Source Electronics Prototyping Platform”, 3rd edition, Maker Media Inc., 2015.
6. Michail Kölling, “Raspberry PI: A complete guide to start learning RaspberryPi on your own”, Francesco Cammardella Publications, 2020.

22EC965 INTRODUCTION TO INTERNET OF THINGS

Source: https://www.zephyrnetworks.com/everything-you-need-to-know-about-iot-devices-and-why-you-should-implement-them-in-your-business/

Hours Per Week :

L	T	P	C
3	0	2	4

PREREQUISITE KNOWLEDGE: Basics of C-programming

COURSE DESCRIPTION AND OBJECTIVES:

This course offers skills on interconnection and integration of the physical world and the cyberspace. The objective of the course is to enable the students to design and develop IoT systems for real-world problems.

MODULE-1

UNIT-1 **12L+0T+8P=20 Hours**

IOT INTRODUCTION & CONCEPTS:

Introduction: Definition and Characteristics of IoT, Physical Design of IoT, Logical Design of IoT, IoT Enabling Technologies, IoT Levels and deployment.

UNIT-2 **12L+0T+8P=20 Hours**

PROTOTYPING & APPLICATIONS:

Prototyping Embedded Devices: Electronics, Embedded Computing Basics, Arduino, ESP8266, Raspberry Pi.

Domain Specific Applications of IoT: Home Automation, Cities, Environment, Energy, Retail, Logistics, Agriculture, Industry, Health & Life Style.

PRACTICES:

- Familiarization with Arduino boards and ESP8266.
- Interfacing of LED and switch with Arduino boards and ESP8266.
- Traffic Light control using Arduino board and ESP8266.
- Interfacing DHT11 sensor with Arduino board and ESP8266.
- Interfacing of ultrasonic sensor with Arduino board and ESP8266.
- Interfacing of PIR sensor with Arduino board and ESP8266.
- DC motor control using L293D motor driver and Arduino board.

MODULE-2

UNIT-1 **12L+0T+8P=20 Hours**

INTERNET PRINCIPLES & M2M:

Internet Principles: Internet communications: An overview, IP addresses, MAC addresses, TCP and UDP ports, Application layer protocols; Python packages of interest for IoT.

M2M: Introduction to M2M, M2M architecture, Difference between IoT and M2M, SDN and NFV for IoT.

UNIT-2 **12L+0T+8P=20 Hours**

IOT DESIGN:

IoT Design: IoT Design Methodology, Python Web Application Framework, Django, Designing a REST full web API.

Case Studies: Home Automation, Smart Cities, Environment, Agriculture, Productivity Applications.

SKILLS:

- ✓ *Use various sensors and actuators for IoT applications.*
- ✓ *Interface programming on I/O devices.*
- ✓ *Develop applications for the Internet of things.*

PRACTICES:

(Both practices and/ or Tutorials should be included in this section only. The list should quantify the T+P hours in this module)

- Familiarization with Raspberry pi.
- Interfacing of LED and switch with Raspberry pi.
- Interfacing PIR sensor with Raspberry pi.
- Interfacing DHT11 sensor with Raspberry pi.
- Interfacing of ultrasonic sensor with Raspberry pi.
- Interfacing of Picam with Raspberry pi.
- Sending email with Raspberry pi.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Interface sensors with various embedded devices.	Apply	1	1, 2,5,12
2	Design the framework necessary for IoT applications	Apply	1	1, 2, 5, 12
3	Develop prototypes for IoT devices	Apply	1	1, 2, 3, 5, 12
4	Assess various internet principles and M2M technologies.	Apply	2	1, 2, 12
5	Classify various advanced IoT applications and case studies.	Apply	2	1, 2

TEXT BOOKS:

1. Vijay Madisetti, Arshdeep Bahga, “Internet of Things A Hands-On- Approach”, 2014.
2. Adrian McEwen, “Designing the Internet of Things”, Wiley Publishers, 2013,

REFERENCE BOOKS:

1. Perry Lea, “Internet of Things for Architects”, 1st edition, Packt Publishing, 2018.
2. Samuel Greengard, “The Internet of Things (Essential Knowledge)”, MIT Press, 2015.
3. Timothy Chou,. Precision: Principles, Practices and Solutions for the Internet of Things, Cloudbook Inc., USA. April-13 2020.

22EC966 IOT ARCHITECTURE

Source: https://www.intigia.com/technologies/industrial-iot/

Hours Per Week :

L	T	P	C
3	0	2	4

PREREQUISITE KNOWLEDGE: Introduction to IoT.

COURSE DESCRIPTION AND OBJECTIVES:

This course introduces the Architecture of IoT, basic concepts of IoT architectures and IoT Levels. The Course emphasizes the constraints, requirements, and architectures of hardware and software components for IoT systems. By the end of the course, a student will be able to: (1) Develop IoT solutions based on popular hardware/software platforms to address real-life problems (2) Evaluate the cost, power, and performance trade-offs associated with IoT solutions.

MODULE-1

UNIT-1 **12L+0T+8P=20 Hours**

IOT REFERENCE MODELS:

Introduction: Introduction to IoT, Applications of IoT, Use cases of IoT, The IoT Architectural Reference Model as Enabler, IoT in Practice: Examples: IoT in Logistics and Health, IoT Reference Model: Domain, information, functional & communication models.

UNIT-2 **12L+0T+8P=20 Hours**

IOT ARCHITECTURE AND PROTOCOLS:

IoT Reference Architecture: Architecture, Functional, information, deployment and operation views; SOA based Architecture, API-based Architecture, OPENIoT Architecture for IoT/Cloud Convergence.

Application Protocols for IoT: UPnP, CoAP, MQTT, XMPP. SCADA, WebSocket; IP-based protocols: 6LoWPAN, RPL; Authentication Protocols; IEEE 802.15.4.

Case study: Cloud-Based Smart-Facilities Management, Healthcare, Environment Monitoring System.

PRACTICES:

- Implementation of home automation system using relay module.
- Implementation of traffic signal control using 6LoWPAN.
- Implementation of railway gate control by stepper motors.
- Direction and speed control of DC Motor.
- Familiarization with Arduino/Raspberry pi .
- To interface LED/Buzzer with Arduino/Raspberry Pi and write a program to turn on led for 1sec after every 2 seconds.
- Write a program on Arduino/Raspberry Pi to publish temperature data to the MQTT broker.
- Write a program on Arduino/Raspberry Pi to subscribe to the MQTT broker for temperature data and print it.

MODULE-2

UNIT-1 **12L+0T+8P=20 Hours**

IIOT REFERENCE ARCHITECTURE:

IIoT Architecture: The IIC Internet Reference Architecture, Industrial Internet Architecture Framework (IIAF), Architectural Topology, The Three-Tier Topology, Connectivity, Key System Characteristics, Data Management.

SKILLS:

- ✓ *Understand the specifications and how well different components work together for IoT Boards.*
- ✓ *Learn different data and number representations.*
- ✓ *Design ALU and Control unit.*
- ✓ *Identify the types of IoT application protocols and their uses.*
- ✓ *To enable the students to take up the real-time industry as well as interdisciplinary projects.*

UNIT-2 **12L+0T+8P=20 Hours**

DESIGNING INDUSTRIAL INTERNET SYSTEMS:

The Concept of the IIoT, The Proximity Network, WSN Edge Node, Legacy Industrial Protocols, Modern Communication Protocols, Wireless, Communication Technologies, Proximity Network Communication Protocols, Gateways Examining the Access Network Technology and Protocols - The Access Network, Access, Networks Connecting Remote Edge Networks

PRACTICES:

- Identify the industrial Sensors
- Interfacing raspberry pi with Boilers
- Implementation of scrolling belt using raspberry pi.
- implementation of the network using raspberry pi.
- To interface Bluetooth with Arduino/Raspberry Pi and write a program to send sensor data to the smartphone using Bluetooth.
- To interface node MCU with Arduino/Raspberry Pi and write a program to send sensor data to the smartphone using Blynk Application/Cloud.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Build the IoT Design with sensors and actuators and analyse the levels of Arduino programming language.	Apply	1	1, 2, 12
2	Make use of sensors for collection data from the physical medium	Apply	1	1, 2, 5, 12
3	Apply the physical layer issues, analyse Medium Access Control Protocols/IoT Protocols	Apply	1	1, 2, 3, 5, 12
4	Categorize various topologies and Data management tools	Analyze	2	1, 2, 12
5	Comprehend network and transport layer characteristics and protocols and implement conventional protocols	Analyze	2	1, 2

TEXT BOOKS:

1. Giacomo Veneri; Antonio Capasso, “Hands-on Industrial Internet of Things : create a powerful Industrial IoT infrastructure using Industry 4.0”, ,Packt Publishing, 2018
2. Vijay Madisetti, ArshdeepBahga,” Internet of Things A Hands-On- Approach”,2014

REFERENCE BOOKS:

1. Bassi, Alessandro, et al, “Enabling things to talk”, Springer-Verlag Berlin An, 2016.
2. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry, “IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things”, CISCO Press, 2017
3. Hersent, Olivier, David Boswarthick, and Omar Elloumi. The internet of things: Key applications and protocols. John Wiley & Sons, 2011.
4. Buyya, Rajkumar, and Amir Vahid Dastjerdi, eds. Internet of Things: Principles and paradigms. Elsevier, 2016
5. Alasdair Gilchrist,“Industry 4.0: The Industrial Internet of Things” by, ISBN: 978-1-4842-2046-7, APRESS, 2016.

22EC967 IOT DESIGN

Source: https://1nce.com/en/blog/iot-device-design/

Hours Per Week :

L	T	P	C
3	0	2	4

PREREQUISITE KNOWLEDGE: Introduction to IoT.

COURSE DESCRIPTION AND OBJECTIVES:

This course emphasis on the design principles for developing an IoT product in the market. The objective of the course is to enable the students to understand the design principles while prototyping the IoT devices.

MODULE-1

UNIT-1 **12L+0T+8P=20 Hours**

DESIGN PRINCIPLES FOR CONNECTED DEVICES:

Introduction, Design Principles for Connected Devices, Calm and Ambient Technology, Magic as Metaphor, Privacy, Web Thinking for Connected Devices, Affordances.

UNIT-2 **12L+0T+8P=20 Hours**

PROTOTYPING EMBEDDED DEVICES:

Thinking About Prototyping: Sketching, Familiarity, Costs versus Ease of Prototyping, Prototypes and Production, Open Source versus Closed Source, Tapping into the Community.

Prototyping Embedded Devices: Electronics, Embedded Computing Basics, Arduino, Raspberry Pi, BeagleBone Black, Electric Imp, Other Notable Platforms

PRACTICES:

- Sense the available networks using Arduino.
- Detect the vibration of an object using Arduino.
- Connect with the available wi-fi using Arduino.

MODULE-2

UNIT-1 **12L+0T+8P=20 Hours**

PROTOTYPING ONLINE COMPONENTS:

Prototyping Online Components: Getting Started with an API, Writing a New API, Real-Time Reactions, Other Protocols

Techniques for Writing Embedded Code: Memory Management, Performance and Battery Life, Libraries, Debugging

UNIT-2 **12L+0T+8P=20 Hours**

FROM PROTOTYPE TO REALITY:

Business Models, Lean Startups, Moving to Manufacture, Designing Kits, Designing Printed circuit boards, Manufacturing Printed Circuit Boards, Ethics, Privacy, Control.

SKILLS:

- ✓ *Design prototypes for IoT applications.*
- ✓ *Able to understand the design principle for IoT.*
- ✓ *Interface I/O devices with APIs.*

PRACTICES:

- Data Logging with Raspberry pi and Thing speak.
- Turn your smartphone into an IoT device.
- Interfacing Arduino with any cloud platform.
- Measure any physical quantity and tweet when it crossed the threshold limit.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Understand the design principles for connected devices.	Apply	1	1, 2,3,5
2	Able to design the framework necessary for IoT applications	Apply	1	1, 2,3,5, 12
3	Develop prototypes for IoT devices	Apply	1	1, 2, 3, 5, 12
4	Develop APIs for IoT applications.	Apply	2	1, 2, 3,12
5	Design business models for IoT.	Apply	2	1, 2, 3

TEXT BOOKS:

1. Adrian McEwen, “Designing the Internet of Things”, Wiley Publishers, 2013.
2. Kamal R. Internet of Things, McGraw Hill, 2017.

REFERENCE BOOKS:

1. Perry Lea, “Internet of Things for Architects”, 1st edition, Packt Publishing, 2018.
2. Samuel Greengard, “The Internet of Things (Essential Knowledge)”, MIT Press, 2015.
3. Timothy Chou,. Precision: Principles, Practices and Solutions for the Internet of Things, Cloudbook Inc., USA. April-13 2020.

22EC968 IOT SECURITY

Source: https://www.speranzainc.com/communication-security-in-iot/

Hours Per Week :

L	T	P	C
3	0	2	4

PREREQUISITE KNOWLEDGE: Introduction to Internet of Things.

COURSE DESCRIPTION AND OBJECTIVES:

This course introduces the methodologies of Cyber Physical systems and the basic Trust models of IoT. The course explores on different threads on IoT applications and provides privacy preservation for real time data using Attack detection techniques, Encryption, Hash Function, Elliptic curves, Signature Algorithms, Consensus Algorithms and Secured Access Protocols.

MODULE-1

UNIT-1 **12L+0T+8P=20 Hours**

CYBER PHYSICAL SYSTEMS & THREADS:

Introduction to IoT –Cyber Physical Systems: IoT and cyber-physicalsystems, IoT security (vulnerabilities, attacks, and countermeasures), security engineering for IoT development, IoT security lifecycle.

IoT as Interconnection of Threats: Network Robustness of Internet of Things- Sybil Attack Detection in Vehicular Networks- Malware Propagation and Control in Internet of Things- Solution-Based Analysis of Attack Vectors on Smart Home Systems

UNIT-2 **12L+0T+8P=20 Hours**

CRYPTO FOUNDATIONS & BLOCK CHAIN:

Crypto Foundations: Block ciphers, message integrity, authenticated encryption, hash functions, Merkle trees, elliptic curves, public-key crypto (PKI), signature algorithms

Block Chain: Crypto-currencies, Bitcoin P2P network, distributed consensus, incentives and proof-of-work, mining, script and smart contracts, wallets: hot and cold storage, anonymity, altcoins.

PRACTICES:

- Implement Block Cipher Encryption.
- Analyze Attacks on smart Home
- Vulnerabilities on IoT devices.
- Implement attacks on IoT.
- Evaluate Cyber-physical systems.
- Design smart contract for real time IoT applications.
- Implement Consensus Algorithm for IoT.
- Implement Sybil Attack Detection.
- Implement Malware Control in Internet of Things.
- Implement elliptic curve cryptography.

MODULE-2

UNIT-1 **12L+0T+8P=20 Hours**

PRIVACY PRESERVATION & TRUST MODELS:

Privacy Preservation for IoT: Privacy Preservation Data Dissemination- Privacy Preservation Data Dissemination- Social Features for Location Privacy Enhancement in Internet of Vehicles- Lightweight

SKILLS:

- ✓ *Understands the state-of-the-art methodologies in Cyber Physical system. 2.*
- ✓ *Knowledge on Model threats and countermeasures.*
- ✓ *Explores the Privacy Preservation and Trust Models in Internet of Things (IoT).*
- ✓ *Designs Internet of Things Security in the real world scenarios.*

and Robust Schemes for Privacy Protection in Key Personal IoT Applications: Mobile WBSN and Participatory Sensing

Trust Models for IoT: Authentication in IoT- Computational Security for the IoT- Privacy-Preserving Time Series Data Aggregation- Secure Path Generation Scheme for Real-Time Green Internet of Things- Security Protocols for IoT Access Networks- Framework for Privacy and Trust in IoT- Policy-Based Approach for Informed Consent in Internet of Things

UNIT-2 **12L+0T+8P=20 Hours**

INTERNET OF THINGS SECURITY:

Security and Impact of the Internet of Things (IoT) on Mobile Networks- Networking Function Security- IoT Networking Protocols, Secure IoT Lower Layers, Secure IoT Higher Layers, Secure Communication Links in IoTs, Back-end Security -Secure Resource Management, Secure IoT Databases, Security Products-Existing Test bed on Security and Privacy of IoTs, Commercialized Products.

PRACTICES:

- Implement IoT Networking protocols.
- Implement authorized login for IoT database.
- Secured IoT Access Networks.
- Security implementation at Lower Layers.
- Security implementation at Higher Layers.
- Design light weight security applications.
- Design policy for IoT data Approach.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Identify the areas of cyber security for the Internet of Things.	Analyze	1	1, 2
2	Assess different Internet of Things technologies and their applications.	Analyze	1	1, 2, 12
3	Model IoT to business	Apply	1	1, 2, 3, 5
4	Customize real time data for IoT applications.	Apply	2	1, 2, 12
5	Solve IoT security problems using light weight cryptography	Analyze	2	1, 2, 3, 5
6	Build security systems using elementary blocks	Apply	2	1, 2, 3, 5

TEXT BOOKS:

1. Hu, Fei. Security and privacy in Internet of things (IoTs): Models, Algorithms, and Implementations, 1 st edition,CRC Press, 2016.
2. Russell, Brian, and Drew Van Duren. Practical Internet of Things Security, 1 st edition, Packt Publishing Ltd, 2016.

REFERENCE BOOKS:

1. Whitehouse O. Security of things: An implementers' guide to cyber-security for internet of things devices and beyond, 1 st edition, NCC Group, 2014
2. DaCosta, Francis, and Byron Henderson. Rethinking the Internet of Things: a scalable approach to connecting everything, 1 st edition, Springer Nature, 2013.
3. Patel Chintan, Nishant Dosji. Internet of Things Security Challenges, Advances and Analysis, 1st Edition, Auerbach, 2018.

22EC969 SENSORS AND ACTUATORS FOR IOT

Source: https://parasam.me/2016/05/19/iot-internet-of-things-a-short-series-of-observations-pt-2-sensors-actuators-infrastructure/

Hours Per Week :

L	T	P	C
3	0	2	4

PREREQUISITE KNOWLEDGE: Introduction to IoT or Embedded Systems.

COURSE DESCRIPTION AND OBJECTIVES:

Explore IoT smart sensor and actuator solutions. Compare types and technical requirements and protocols across market industries. Develop solutions for IoT using various sensors and actuators.

MODULE-1

UNIT-1 **12L+0T+8P=20 Hours**

INTRODUCTION TO SENSORS & ACTUATORS:

Definitions, Classification of sensors and Actuators, General Requirement for interfacing, Units.

Input output characteristics, Transfer function, Range, Span, input and Output full scale, resolution and dynamic range, accuracy, errors, and repeatability, sensitivity and sensitivity analysis, hysteresis, nonlinearity, and saturation, Frequency response, response time, and bandwidth, Calibration, excitation, deadband, reliability.

UNIT-2 **12L+0T+8P=20 Hours**

PRINCIPLES OF SENSORS:

Principles of sensing (Basics) : Capacitance, Magnetism, Resistance, Induction, Piezoelectric effect, Hall effects, Thermoelectric Effects

Ultrasonic Detectors, Optoelectronic Motion Detectors, Optical Presence Sensors, Pressure-Gradient Sensors, 2-D Pointing Devices, Gesture Sensing (3-D Pointing), Tactile Sensors

PRACTICES:

- Find the input characteristics of capacitive sensors
- Measure the range, sensitivity hysteresis, nonlinearity of temperature sensors
- Measure the frequency response of temperature sensor
- Measure the range of optical sensors and calibrate its use for displacement measurement.
- Calibrate a hall effect sensor
- Measure the displacement range, linearity, frequency response of piezoelectric sensor
- Measure the sensitivity of resistance sensors and establish their input characteristics
- Establish sensitivity, range, linearity and frequency response of tactile sensors.

MODULE-2

UNIT-1 **12L+0T+8P=20 Hours**

INTERFACING ELECTRONICS FOR SENSORS:

Signal Conditioners: Input Characteristics, Amplifiers, Operational Amplifiers, Voltage Follower, Charge- and Current-to-Voltage Converters, Light-to-Voltage Converters, Capacitance-to-Voltage Converters, Closed-Loop Capacitance-to-Voltage Converters

Data Acquisition: Data Acquisition, Sensor Classification, Units of Measurements

Analog-to-Digital Converters: Basic Concepts, Digital to analog converters, V/F Converters, PWM Converters, R/F Converters, Successive-Approximation Converter, Resolution Extension, ADC Interface

SKILLS:

- ✓ *Analyze characteristics of various sensors.*
- ✓ *Choose sensors based on application.*
- ✓ *Design interfacing circuitry for sensors and actuators.*

UNIT-2 **12L+0T+8P=20 Hours**

ACTUATORS & INTERFACING:

Thermal actuators, Optical actuators, Capacitive actuators, Magnetic actuators, magnetrostrictive actuators, Acoustic actuators, Electromagnetic actuators (DC, Stepper motors) and their control principles

Interfacing to microprocessor/microcontrollers. Microprocessor as general-purpose controller, General requirements for interfacing sensors and actuators. Interfacing examples

PRACTICES:

- Develop signal conditioning circuit for low level signals along with noise removal
- Develop a digital circuit for amplification of the capacitive sensor and establish various characteristics.
- Develop a digital circuit for measuring the optical sensitivity of optical sensor
- Control the rotation of stepper motor to precise angle without any sensors
- Tracking object by controlling servo motor precisely.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Identify sensors for selection of a specific physical parameter	Apply	1	1, 2, 12
2	Interface the sensor with different data acquisition systems	Create	2	1, 2, 5, 12
3	Control various actuators	Apply	2	1, 2, 3, 5, 12
4	Design a signal conditioner for the given sensor	Create	2	1, 2, 12
5	Select a sensor for a given application based on its principle of operation	Evaluate	1	1, 2

TEXT BOOKS:

1. Nathan Ida, Senosrs, Actuators, and Their Interfaces-A Multideisciplinary introduction, 2nd Edition, IET London UK, 2020
2. Jacob Fraden, Handbook of Modern Sensors Physics, Designs, and Applications, Fifth Edition, Springer, 2016

REFERENCE BOOKS:

1. John G. Webster, The Measurement Instrumentation and Sensors, CRC Press, 1999
2. Francisco André Corrêa Alegria, Sensors and Actuators, World Scientific Publichisng Co. Pvt. Ltd., 2022.
3. Ammar Rayes, Samer Salam, “Internet of Things from Hype to Reality”, Springer, 2022.

HONOURS

ELECTRONICS AND COMMUNICATION ENGINEERING

B.Tech.

- 22EC951 - Advanced Deep Learning and Computer Vision
- 22EC952 - Applied Data Science With Python
- 22EC954 - Reinforcement Learning in Python

COURSE CONTENTS

I SEM & II SEM

22EC951 ADVANCED DEEP LEARNING AND COMPUTER VISION

Source: https://www.biostat.wisc.edu/~yli/bmi826_cs838_19fall/

Hours Per Week :

L	T	P	C
2	0	4	4

PREREQUISITE KNOWLEDGE: Machine Learning and Computer Vision/Image Processing, Statistics and Linear Algebra.

COURSE DESCRIPTION AND OBJECTIVES:

This course will introduce the learner to the basics of computer vision and implementation of advanced topics like object detection, segmentation and recognition using deep learning techniques. The course will introduce pretrained nets, GANs and transformer models.

MODULE –1

UNIT-1 **8L+0T+16P=20 Hours**

FUNDAMENTALS:

Introduction to Image Formation, Capture and Representation; Linear Filtering, Correlation, Convolution; Visual Features and Representations: Edge, Blobs, Corner Detection; Scale Space and Scale Selection; SIFT, SURF; HoG, LBP, etc.; Visual Matching: Bag-of-words, VLAD; RANSAC, Hough transform; Pyramid Matching; Optical Flow

UNIT-2 **8L+0T+16P=20 Hours**

CONVOLUTIONAL NEURAL NETWORKS:

Convolutional Neural Networks (CNNs): Introduction to CNNs; Evolution of CNN Architectures: AlexNet, ZFNet, VGG, Inception Nets, ResNets, DenseNets

PRACTICES:

- Perform the feature detection using SIFT, SURF; HoG, LBP feature descriptors
- Perform the feature matching using RANSAC
- Implement a Pyramid Matching
- Implement classification using CNN

MODULE-2

UNIT-1 **8L+0T+16P=20 Hours**

CNNS FOR RECOGNITION, VERIFICATION, DETECTION, SEGMENTATION:

CNNs for Detection: Background of Object Detection, R-CNN, Fast R-CNN, Faster R-CNN, YOLO, SSD, RetinaNet; CNNs for Segmentation: FCN, SegNet, U-Net, Mask-RCNN

UNIT-2 **8L+0T+16P=20 Hours**

ATTENTION MODELS:

Introduction to Attention Models in Vision; Vision and Language: Image Captioning, Visual QA, Visual Dialog; Spatial Transformers; Transformer Networks; Deep Generative Models: Review of Deep Generative Models: GANs.

PRACTICES/ TUTORIALS:

- Object detection using R-CNN and Yolo

SKILLS:

- ✓ *Handle Feature descriptors.*
- ✓ *Design and implementation of various problems using CNN, GAN and transformer models.*

- Object recognition using YoLo.
- Detect cations in pictures
- Generate the object where the ground truth is not available using GAN
- Generate applications using Transformer.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply the concepts of fundamentals of image formation and feature extraction	Apply	1,2	1, 2, 3, 4, 5, 9,10, 12
2	Integrate machine learning libraries and mathematical and statistical tools with modern technologies.	Apply	1	1, 2, 3, 4, 5, 9,10, 12
3	Apply techniques for the implementation of object detection and segmentation	Apply	2	1, 2, 3, 4, 5, 9,10, 12
4	Build the concept to a real problem, optimize the models learned and report on the expected accuracy that can be achieved by applying the models	Apply	1, 2	1, 2, 3, 4, 5, 9,10, 12
5	Analyze the problems using GAN models and transformer models.	Evaluate	2	1, 2, 3, 4, 5, 9,10, 12

TEXT BOOKS:

1. Ian Goodfellow, Yoshua Bengio, Aaron Courville, Deep Learning, 2016
2. Simon Prince, Computer Vision: Models, Learning, and Inference, 2012.

REFERENCES BOOKS:

1. Richard Szeliski, Computer Vision: Algorithms and Applications, 2010.
2. David Forsyth, Jean Ponce, Computer Vision: A Modern Approach, 2002.
3. Michael Nielsen, Neural Networks and Deep Learning, 2016
4. Yoshua Bengio, Learning Deep Architectures for AI, 2009.

22EC952 APPLIED DATA SCIENCE WITH PYTHON

Source: https://www.classcentral.com/course/python-data-science-18393

Hours Per Week :

L	T	P	C
3	0	2	4

PREREQUISITE KNOWLEDGE: Basic programming language, data structure.

COURSE DESCRIPTION AND OBJECTIVES:

This course will introduce the learner to the basics of the python programming environment, including fundamental python programming techniques such as reading and manipulating csv files, and the Numpy library. The course will also introduce data manipulation and cleaning techniques along with visualization.

MODULE - 1

UNIT-1 **12L+0T+8P=20 Hours**

FUNDAMENTALS:

Python Program Execution Procedure – Statements – Expressions – Flow of Controls – Functions – Numeric Data Types – Sequences – Strings – Tuples – Lists – Dictionaries. Class – Constructors – Object Creation – Inheritance – Overloading. Text Files and Binary Files – Reading and Writing.

UNIT-2 **12L+0T+8P=20 Hours**

NUMPY AND PANDAS PACKAGES:

NumPy ndarray - Vectorization Operation - Array Indexing and Slicing - Transposing Array and Swapping Axes - Saving and Loading Array - Universal Functions - Mathematical and Statistical Functions in Numpy.

Series and Data Frame data structures in pandas - Creation of Data Frames – Accessing the columns in a DataFrame - Accessing the rows in a DataFrame - Panda's Index Objects - Reindexing Series and DataFrames - Dropping entries from Series and Data Frames - Indexing, Selection and Filtering in Series and Data Frames - Arithmetic Operations between Data Frames and Series - Function Application and Mapping.

PRACTICES:

- Perform Creation, indexing, slicing, concatenation and repetition operations on Python built-in data types: Strings, List, Tuples, Dictionary, Set
- Solve problems using decision and looping statements.
- Apply Python built-in data types: Strings, List, Tuples, Dictionary, Set and their methods to solve any given problem
- Create NumPy arrays from Python Data Structures, Intrinsic NumPy objects and Random Functions.
- Manipulation of NumPy arrays- Indexing, Slicing, Reshaping, Joining and Splitting.
- Computation on NumPy arrays using Universal Functions and Mathematical methods.

MODULE-2

UNIT-1 **12L+0T+8P=20 Hours**

DATA WRANGLING:

Combining and Merging Data Sets – Reshaping and Pivoting – Data Transformation – String manipulations – Regular Expressions.

SKILLS:

- ✓ *Handle storage and data operations using NumPy arrays.*
- ✓ *Design an application with user-defined modules and packages using OOP concept.*
- ✓ *Demonstrate data preprocessing and visualization using Pandas.*

UNIT-2 **12L+0T+8P=20 Hours**

VISUALIZATION IN PYTHON:

Matplotlib and Seaborn Packages – Plotting Graph - Controlling Graphs – Adding Text – More Graph Types – Getting and Setting Values – Patches.

PRACTICES/TUTORIALS:

- Handle missing data by detecting and dropping/ filling missing values.
- Transform data using apply() and map() method.
- Detect and filter outliers.
- Perform Vectorized String operations on Pandas Series.
- Visualize data using Line Plots, Bar Plots, Histograms, Density Plots and Scatter Plots

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply various Python data structures to effectively manage various types of data.	Apply	1,2	1, 2, 3, 4, 5, 9,10, 12
2	Analyze data science pipeline with role of Python.	Analyze	1	1, 2, 3, 4, 5, 9,10, 12
3	Apply data Wrangling with Numpy for exploratory data analysis	Apply	2	1, 2, 3, 4, 5, 9,10, 12
4	Apply data visualization tools for effective interpretations and insights of data.	Apply	2	1, 2, 3, 4, 5, 9,10, 12

TEXT BOOKS:

1. Wes McKinney, “Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython”, O’Reilly, 2nd Edition, 2018.
2. Jake VanderPlas, “Python Data Science Handbook: Essential Tools for Working with Data”, O’Reilly, 2017.

REFERENCE BOOKS:

1. Alex Galea, “Applied Data Science with Python and Jupyter”, Packt Publishing Limited, 2018.
2. Gowrishanker and Veena, “Introduction to Python Programming”, CRC Press, 2019.
3. Leo Chin and Tanmay Dutta, “NumPy Essentials”, Packt Publishing Limited, 2016.
4. Wes Mc Kinney, “Python for Data Analysis”, O’Reilly Media, 2012.
5. Y. Daniel Liang, “Introduction to Programming using Python”, Pearson, 2012.
6. Jake Vanderplas, “Python Data Science Handbook: Essential Tools for Working with Data”, 1st Edition, O’Reilly Media, 2017.

22EC954 REINFORCEMENT LEARNING IN PYTHON

Hours Per Week :

L	T	P	C
3	2	0	4

Source: https://www.learndatasci.com/tutorials/reinforcement-q-learning-scratch-python-openai-gym/

PREREQUISITE KNOWLEDGE: Introduction to Image Processing, Artificial Intelligence, Machine Learning, and Q Learning.

COURSE DESCRIPTION AND OBJECTIVES:

Reinforcement learning is an area of machine learning where an agent learns how to behave in an environment by performing actions and assessing the results. Students will study the fundamentals and practical applications of reinforcement learning and will cover the latest methods used to create agents that can solve a variety of complex tasks, with applications ranging from gaming to finance to robotics.

MODULE - I

UNIT-1 **12L+8T+0P=20 Hours**

FOUNDATIONS:

Introduction and Basics of RL, Defining RL Framework and Markov Decision Process, Polices, Value Functions and Bellman Equations, Exploration vs. Exploitation, Code Standards and Libraries used in RL (Python/Keras/Tensorflow).

UNIT-2 **12L+8T+0P=20 Hours**

TABULAR METHODS AND Q-NETWORKS:

Planning through the use of Dynamic Programming and Monte Carlo, Temporal-Difference learning methods (TD(0), SARSA, Q-Learning) Deep Q-networks (DQN, DDQN, Dueling DQN, Prioritised Experience Replay).

PRACTICES:

- Implement in code common algorithms following code standards and libraries used in RL.
- Understand and work with tabular methods to solve classical control problems.
- Understand and work with approximate solutions.

MODULE-2

UNIT-1 **12L+8T+0P=20 Hours**

POLICY OPTIMIZATION:

Introduction to policy-based methods, Vanilla Policy Gradient, REINFORCE algorithm and stochastic policy search, Actor-critic methods (A2C, A3C), Advanced policy gradient (PPO, TRPO, DDPG).

UNIT-2 **12L+8T+0P=20 Hours**

RECENT ADVANCES AND APPLICATIONS:

Model-based RL approach, Meta-learning, Multi-Agent Reinforcement Learning, Partially Observable Markov Decision Process, Ethics in RL.

PRACTICES/TUTORIALS:

- Explore imitation learning tasks and solution.
- Applying RL for real-world problems.
- Capstone project.

SKILLS:

- ✓ *Examine code standards and libraries used in RL.*
- ✓ *Demonstrate various Learning methods.*
- ✓ *Create, run and manipulate Python Programs with Keras or Tensorflow.*

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Learn and apply the policies, value functions, Bell-man equations in RL using Python/ Keras/ Tensor-flow.	Apply	1	1, 2, 3, 4, 5, 9, 10, 12
2	To solve classical control problems with tabular methods.	Apply	1	1, 2, 3, 4, 5, 9, 10, 12
3	Apply and Analyze the concepts of policy-based methods, Actor-critic methods and Advanced policy gradient for RL.	Analyze	2	1, 2, 3, 4, 5, 9, 10, 12
4	Develop an application using RL.	Create	2	1, 2, 3, 4, 5, 9, 10, 12

TEXT BOOKS:

1. Richard S. Sutton and Andrew G. Barto, “Reinforcement learning: An introduction”, Second Edition, MIT Press, 2019.
2. Russell, Stuart J., and Peter Norvig. “Artificial intelligence: a modern approach”, Pearson Education Limited, 2016.

REFERENCE BOOKS:

1. Goodfellow, Ian, Yoshua Bengio, and Aaron Courville. “Deep learning.” MIT press, 2016.
2. Zed A. Shaw, “Learn Python 3 the Hard Way: A Very Simple Introduction to the Terrifyingly Beautiful World of Computers and Code”, Addison-Wesley Professional, 2017.
3. James Herron, “Python Programming For Beginners”, Kindle Edition, 2021.

HONOURS

ELECTRONICS AND COMMUNICATION ENGINEERING

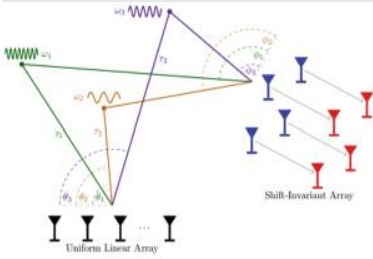
B.Tech.

22EC955	-	Array Signal Processing
22EC956	-	Free Space Optics
22EC957	-	Fundamentals of Massive MIMO
22EC958	-	Information Theory and Coding
22EC959	-	SDR for Future Communication Systems
22EC960	-	Wavelet Theory and Applications

COURSE CONTENTS

I SEM & II SEM

22EC955 ARRAY SIGNAL PROCESSING



Source: https://www.nts.tu-darmstadt.de/forschung_nts/forschungsprojekte_nts/array_proc/index.de.jsp

Hours Per Week :

L	T	P	C
3	2	0	4

PREREQUISITE KNOWLEDGE: Basics of Digital signal processing.

COURSE DESCRIPTION AND OBJECTIVES:

To introduce the student to the various aspect of array signal processing, and the Spatial Sampling theorem. Various array design methods and direction of arrival estimation techniques are discussed in this course.

MODULE –1

UNIT-1 **12L+8T+0P=20 Hours**

SPATIAL SIGNALS:

Introduction: Signals in space and time, Spatial Frequency vs. Temporal Frequency, Review of Co-ordinate Systems, Maxwell's Equation, and Wave Equation. Solution to Wave equation in Cartesian Co-ordinate system -Wavenumber vector, Slowness vector, Wavenumber -Frequency Space. Wavenumber -Frequency Space

UNIT-2 **12L+8T+0P=20 Hours**

SPATIAL SAMPLING:

Spatial Sampling Theorem-Nyquist Criteria, Aliasing in Spatial frequency domain, Spatial Frequency Transform, Spatial spectrum. Spatial Domain Filtering. Beam Forming. Spatially white signal, Spatial sampling of multidimensional signals.

PRACTICES:

- Identifying the stationarity of the real-world signals.
- Compute and plot the Fourier spectrum of signal.
- Use the short-time Fourier transform to plot the spectrum of the real-world signals.
- Wavelet properties, bases and their applications.

MODULE-2

UNIT-1 **12L+8T+0P=20 Hours**

SENSOR ARRAYS:

Linear Arrays, Planar Arrays, Frequency - Wavenumber Response and Beam pattern, Array manifold vector, Conventional Beamformer, Narrowband beamformer. Uniform Linear Arrays: Beam pattern in θ, u and ψ -space Uniformly Weighted Linear Arrays. Beam Pattern Parameters: Half Power Beam Width, Distance to First Null, Location of side lobes and Rate of Decrease, Grating Lobes, Array Steering

UNIT-2 **12L+8T+0P=20 Hours**

ARRAY DEISNG METHODS:

Visible region, Duality between Time -Domain and Space-Domain Signal Processing, Schelkunoff's Zero Placement Method, Fourier Series Method with windowing, Woodward -Lawson Frequency-Sampling Design, Narrow-beam low-side lobe design methods Narrow Band Direction of Arrival Estimation: Non parametric method -Beam forming, Delay and sum Method, Capons Method. Subspace Methods -MUSIC, Minimum Norm and ESPIRIT techniques

SKILLS:

- ✓ *Generate array steering vector for Uniform linear arrays*
- ✓ *Use of fist null width, side lobe(grating lobes) in the accuracy of Direction of Arrival*
- ✓ *Selection of DOA estimation method based on the design criteria ,accuracy, performance*
- ✓ *Finding DOA of narrowband signal using MUSIC algorithm*
- ✓ *Finding DOA of narrow band signal using ESPRIT algorithm*

PRACTICES:

- Compute the Wavenumber of spatiotemporal signal
- Generate Array Manifold Vector for Uniform Linear Arrays
- From a given radiation pattern/beam pattern mark Half power beam Width, First Null, Grating lobes
- Compare and contrast the duality between time and spatial domains
- Compute the direction of arrival of a Narrowband signal using MUSIC technique
- Computer the direction of arrival of a Narrowband signal usi9ng ESPRIT technique

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Analyze theory of array signal processing.	Analyze	1,2	1,2, 9, 10, 12
2	Evaluate the Nyquist frequency and analyzing its impact on accuracy of the estimation technique	Evaluate	1	1, 2, 3,4, 5, 9, 10, 12
3	To Analyze the accuracy of various DoA estimation methods under different conditions	Analyze	2	1, 2, 3,4, 5, 9, 10, 12
4	Design a Uniform Linear Array and analyzing its steering vector , beam pattern	Apply	1	1, 2, 3,4, 5, 9, 10, 12
5	Apply the practical use of beamforming and DOA in everyday applications	Apply	1,2	1, 2, 3,4, 9, 10, 12

TEXT BOOKS:

1. Johnson, Don H., and Dan E. Dudgeon. Array Signal Processing: Concepts and Techniques. PTR Prentice Hall, 2002.
2. Stoica, Petre, and Randolph L. Moses. Spectral Analysis of Signals. Upper Saddle River, N.J: Pearson/Prentice Hall, 2005.

REFERENCES BOOKS:

1. Bass J, Mc Pheeters C, Finnigan J, Rodriguez E. Array Signal Processing [Connexions Web site]. February 8, 2005. Available at:http://cnx.rice.edu/content/coll0255/1.3/
2. Chellappa, Rama, and Sergios Theodoridis. Academic Press Library in Signal Processing: Volume 2, 2014.
3. Van, Trees H. L. Optimum Array Processing: Part IV of Detection, Estimation and Modulation Theory. New York: John Wiley & Sons, 2002.

22EC956 FREE SPACE OPTICS

Source: http://www.fsona.com/technology.php?sec=fso_comparisons

Hours Per Week :

L	T	P	C
2	2	2	4

PREREQUISITE KNOWLEDGE: Basics of Optical Communication

COURSE DESCRIPTION AND OBJECTIVES:

The goal of this course is to build a grasp of the fundamental concepts of free space optical communication in engineering. The methods for establishing and analyzing free space optical link will be the primary focus. Students will learn optical communication through wireless channel by considering different types of atmospheric factors such as effect of turbulence and weather conditions viz., drizzle, haze fog on error performance and channel capacity, link availability.

MODULE - 1

UNIT-1 **6L+6T+6P=18 Hours**

INTRODUCTION:

General introduction, optical channel - Beam divergence, atmospheric losses, weather condition influence, atmospheric turbulence effects viz., scintillation, beam wander, beam spreading, etc.

UNIT-2 **10L+10T+10P=30 Hours**

CHANNEL MODELLING:

Linear time invariant model, channel transfer function, optical transfer function, models of turbulence induced fading viz., lognormal, exponential, K distribution, I- distribution, gamma-gamma distribution, Optical wave models - Plane, spherical and Gaussian, range equation, transmitting and receiving antenna gains.

BACKGROUND NOISE EFFECTS:

Background noise source, detector FOV, diffraction limited FOV, spatial modes, background noise power calculation.

PRACTICES:

- Study the beam divergence.
- Determine the effects of atmospheric losses on optical signal.
- Determine the effects of atmospheric turbulence on optical signal.
- Study the effects of noise on optical free space communication link.

MODULE-2

UNIT-1 **8L+8T+8P=24 Hours**

MODULATION AND DETECTION TECHNIQUES MODULATION TECHNIQUES:

Power efficiency, BW efficiency, bit versus symbol error rates, error rate evaluation for isochronous modulation schemes viz., M-PPM, OOK, mxnPAPM schemes, subcarrier modulation, an isochronous modulation schemes - DPPM, DHPIM, DAPPM, psd and bandwidth requirement.

DETECTION TECHNIQUES:

Photon counter, PIN/APD, PMT, coherent techniques viz., homodyne and heterodyne, bit error rate evaluation in presence of atmospheric turbulence, concept of adaptive threshold.

SKILLS:

- ✓ *Design and test an atmospheric turbulence model.*
- ✓ *Choose the various weather conditions and apply to optical links.*
- ✓ *Analyze the various photo detectors for free space links.*

UNIT-2 **8L+8T+8P=24Hours**

WEATHER IMPAIRMENTS

Effect of turbulence and weather conditions viz., drizzle, haze fog on error performance and channel capacity, link availability.

PRACTICES:

- Compute the power efficiency of optical signals.
- Compute the bandwidth efficiency of optical signals.
- Evaluate the error rate for isochronous modulation schemes.
- Study the characteristics of PIN detector.
- Study the characteristics of APD detector.
- Evaluate the bit error rate in presence of atmospheric turbulence.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply atmospheric channels for the intended terrestrial free space optical link.	Apply	1	1, 2, 4, 5, 9, 10, 12
2	Apply the concepts of OWC to calculate the system performance under background noise effects.	Apply	1, 2	1, 2, 5, 9, 10
3	Analyze various modulation/demodulation techniques in designing of transmitter/receiver for OWC system.	Analyze	1, 2	1, 2, 3, 5, 9, 10
4	Compare various detection techniques under various atmospheric conditions.	Analyze	2	1, 2, 5, 9, 10, 12
5	Evaluate the OWC system under different weather conditions.	Evaluate	1, 2	1, 2, 3, 4, 5, 9, 10, 12

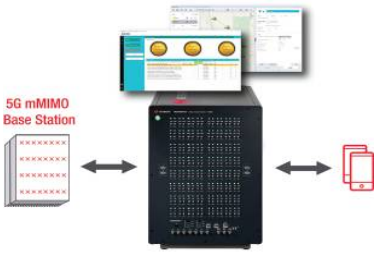
TEXT BOOKS:

1. Z. Ghassemlooy, W. Popoola, S. Rajbhandari, “Optical Wireless Communications”, 1st Ed., CRC Press, 2013.
2. L. C. Andrews, R.L.Phillips, “Laser Beam Propagation through Random Media”, 2nd Ed., SPIE Press, USA, 2005.

REFERENCE BOOKS:

1. J. H. Franz, V. K. Jain, “Optical Communications: Components and Systems”, 1st Ed., Narosa Publishing House, 2000.
2. D. Chadha, “Terrestrial Wireless Optical Communication”, 1st Ed., Tata McGraw-Hill, 2012.
3. Ramaswami Rajiv and Sivarajan K. N., “Optical Networks A Practical Perspective”, Elsevier, 3rd Ed., Morgan Kaufmann Publishers, 2009.

22EC957 FUNDAMENTALS OF MASSIVE MIMO



Source:https://www.keysight.com/in/en/product/S8803A/massive-mimo-base-station-fading-performance-toolset.html

Hours Per Week :

L	T	P	C
3	2	0	4

PREREQUISITE KNOWLEDGE: Basics of wireless communications and Linear Algebra.

COURSE DESCRIPTION AND OBJECTIVES:

The course deals with basic knowledge on Massive MIMO concepts and analysing the uplink and downlink data transmission in case of single cell systems and multi cell systems. The objective of the course is to develop the Massive MIMO techniques and algorithms to cater the needs of future wireless communication systems.

MODULE - I

UNIT-I **12L+8T+0P=20 Hours**

INTRODUCTION:

Point-to- point MIMO, Multi-user MIMO, Massive MIMO, and Time Division verses Frequency Division Duplexing

Single-Antenna Transmitter and Single-Antenna Receiver-Coherence Time, Coherence Bandwidth, Coherence Interval, Interpretation of Tc and Bc in Terms of Nyquist Sampling Rate

UNIT-II **12L+8T+0P = 20 Hours**

HOURS SINGLE CELL SYSTEMS:

Uplink and Downlink data transmission: Zero-Forcing, Maximum-Ratio

PRACTICES:

- Simulation of BER Performance Analysis of MIMO under Perfect CSI
- Simulation of downlink Massive MIMO using Zero-forcing receiver
- Simulation of downlink Massive MIMO using Maximal ratio combining

MODULE-II

UNIT-I **12L+8T+0P = 20 Hours**

MULTI CELL SYSTEMS:

Uplink and Downlink data transmission: Zero-Forcing, Maximum-Ratio

UNIT- II **12L+8T+0P = 20 Hours**

MASSIVE MIMO PROPAGATION CHANNEL:

Favourable Propagation and Deterministic channels, Favourable Propagation and Random Channels, Finite-Dimensional Channels

PRACTICES:

- Simulation of downlink data transmission for multi-cell system using Zero-forcing receiver
- Simulation of downlink data transmission for multi-cell system using Maximum ratio combining.
- Energy Efficient Massive MIMO 5G System with ZF Receiver.
- Simulation of BER Performance Analysis of Massive MIMO Networks under Perfect CSI

SKILLS:

- ✓ *Able to understand the MIMO systems.*
- ✓ *Mathematical analysis of uplink data transmission.*
- ✓ *Selection of the channel for the data transmission.*
- ✓ *Maximization of SNR for massive MIMO.*

- Simulation of BER Performance Analysis of Massive MIMO Networks under Imperfect CSI

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	To understand and analyse Massive MIMO systems with baseband signal processing aspects.	Analyse	1	1,2
2	Model and simulate a massive MIMO system	Create	1,2	1,2,5
3	Analyse complex wireless communication systems under various fading conditions	Analyse	1,2	1,2,5,12
4	Analyse the BER performance of Massive MIMO Systems	Analyse	1,2	1,2,5,9,12
5	Design of Massive MIMO communication system	Application	1,2	1,2,5,12

TEXT BOOKS:

1. Thomas L. Marzetta, Erik G. Larsson, Hong Yang and HienQuoc Ngo, “Fundamentals of Massive MIMO”, Cambridge University Press 2016.
2. David Tse and PramodViswanath, “Fundamentals of Wireless Communication”, Cambridge University Press 2005

REFERENCE BOOKS:

1. EzioBiglieri , Robert Calderbank et al “MIMO Wireless Communications” Cambridge University Press 2007.
2. Daniel W. Bliss and SiddhartanGovindasamy, “Adaptive Wireless Communications: MIMO Channels and Networks”, Cambridge University Press, 2013.

22EC958 INFORMATION THEORY AND CODING

Source: https://www.e-booksdirectory.com/listing.php?category=99

Hours Per Week :

L	T	P	C
3	2	0	4

PREREQUISITE KNOWLEDGE: Basics of Digital Communication.

COURSE DESCRIPTION AND OBJECTIVES:

To introduce the student to the various aspect of the information theories and their coding, to implement the algorithms of coding. Various array design methods and direction of arrival estimation techniques are discussed in this course.

MODULE-1

UNIT-1 **12L+8T+0P=20 Hours**

INTRODUCTION:

Information – Entropy, Information rate, classification of codes, Kraft McMillan inequality, Source coding theorem, Shannon-Fano coding, Huffman coding, Extended Huffman coding - Joint and conditional entropies, Mutual information - Discrete memory less channels – BSC, BEC – Channel capacity, Shannon limit

UNIT-2 **12L+8T+0P=20 Hours**

BLOCK AND CONVOLUTION CODES:

BLOCK CODES: Definitions and Principles: Hamming weight, hamming distance, Minimum distance decoding - Single parity codes, Hamming codes, Repetition codes - Linear block codes, Cyclic codes - Syndrome calculation, Encoder and decoder – CRC

Convolution codes – code tree, trellis, state diagram - Encoding – Decoding: Sequential search and Viterbi algorithm – Principle of Turbo coding

PRACTICES:

- Determination of entropy of a given source
- Determination of various entropies and mutual information of a given channel (Noise free channel)
- Determination of various entropies and mutual information of a given channel (Binary symmetric channel)

MODULE-2

UNIT-1 **12L+8T+0P=20 Hours**

SOURCE CODING:

TEXT, AUDIO AND SPEECH Text: Adaptive Huffman Coding, Arithmetic Coding, LZW algorithm – Audio: Perceptual coding, Masking techniques, Psychoacoustic model, MEG Audio layers I, II, III, Dolby AC3 - Speech: Channel Vocoder, Linear Predictive Coding

UNIT-2 **12L+8T+0P=20 Hours**

2D SOURCE CODING:

Image and Video Formats – GIF, TIFF, SIF, CIF, QCIF – Image compression: READ, JPEG – Video Compression: Principles-I, B, P frames, Motion estimation, Motion compensation, H.261, MPEG standard

SKILLS:

- ✓ *Define the information theories and the types of coding*
- ✓ *Define the algorithms used in coding*
- ✓ *Implement the information theories techniques*
- ✓ *Compute the capacity of various types of channels*
- ✓ *Develop the various coding algorithms.*

PRACTICES:

- Evaluation of variable length source coding using Huffman Coding and decoding
- Coding and decoding of convolutional codes

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Learn and apply the concepts of different coding techniques for data transmission.	Apply	1	1, 2, 4, 5, 9, 10, 12
2	To solve classical problems with linear blocks.	Apply	1	1, 2, 4, 5, 9, 10, 12
3	Apply and analyze the various masking techniques.	Analyze	1,2	1, 2, 3, 5, 9, 10
4	Image compression and extraction.	Apply	2	1, 2, 4, 5, 9, 10, 12

TEXT BOOKS:

1. Ranjan Bose, Information Theory, Coding and Cryptography, Publication,2005
2. Cover, Thomas, and Joy Thomas. Elements of Information Theory. 2nd ed. New York, NY: Wiley-Inter science, 2006. ISBN: 9780471241959

REFERENCE BOOKS:

1. Thomas M. Grover and Joy A. Thomas, “Elements of Information Theory,” Wiley.
2. John G. Proakis and Masoud Salehi, “Digital Communications,” 5th edition, McGraw Hill.

22EC959 SDR FOR FUTURE COMMUNICATION SYSTEMS

Source: https://militaryembedded.com/comms/sdr/software-defined-radio-key-seamless-effective-military-communication

Hours Per Week :

L	T	P	C
3	2	0	4

PREREQUISITES KNOWLEDGE: Basics of Digital Communication and Signal Processing.

COURSE DESCRIPTION AND OBJECTIVES:

The objective of this course is to provide knowledge of fundamental and state-of-the art concepts in software defined radio.

MODULE 1

UNIT-I **12L+8T+0P=20 Hours**

INTRODUCTION TO SDR:

Application of SDR in advanced communication systems, Challenges and issues regarding the implementation of SDR, Adaptive wireless communication systems, Spectrum efficiency and soft spectrum usage, Spectrum sensing, design principles of SDR.

Challenge of Receiver Design: RF receiver front-end topologies, Enhanced flexibility of the RF chain with software radios, Importance of the components to overall performance, Transmitter architectures and their issues, Noise and distortion in the RF chain.

UNIT-2 **12L+8T+0P=20 Hours**

ADC AND DAC DESIGN CHALLENGES:

Direct digital synthesis with analog signal synthesis, Approaches to direct digital synthesis, Analysis of spurious signals, Spurious components due to periodic jitter, Bandpass signal generation, Performance of direct digital synthesis systems, Hybrid DDS-PLL systems, Applications of direct digital synthesis.

PRACTICES:

- Simulation of basic Communication system using SDR
- Study of challenges in SDR for communications
- SDR architecture and issues- a case study
- Analysis of DDS
- Study of hybrid DDS-PLL systems

MODULE 2

UNIT-1 **12L+8T+0P=20 Hours**

DIGITAL HARDWARE CHOICES:

Introduction, Key hardware elements, DSP processors, FPGA, Tradeoffs in using DSPs FPGAs and ASICs, Power management issues, Combinations of DSPs , FPGAs and ASICs.

UNIT-2 **12L+8T+0P=20 Hours**

INTRODUCTION TO COGNITIVE RADIO:

Case study of different SDR platforms, Hands on demos on SDR platform to conduct digital communication experiments.

SKILLS:

- ✓ *Design and simulate digital communication system using SDR for multi standard communications.*
- ✓ *Simulate a SDR platform for Transmission and Receiving the signals.*
- ✓ *Choose the desired platform for SDR implementation*

PRACTICES:

- Study and identification of Hardware for SDRs
- Study of tradeoffs in DSP, FPGA and ASIC.
- Implemenation of SDR based communication systems
- Specific SDR based experimentation using Matlab and Hardware.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Outline the various SDRs and Apply techniques for Digital Communication implementation	Apply	1	1, 2, 4, 5, 9, 10, 12
2	Identify the SDR for proper multi standard communication systems.	Apply	1, 2	1, 2, 5, 9, 10
3	Analyse the SDR for proper transmission and reception of Digital communications	Analyze	1, 2	1, 2, 3, 5, 9, 10
4	Inspect the SDRs for multi standard communication systems.	Analyze	2	1, 2, 5, 9, 10, 12
5	Evaluate the performance of various SDRs for error free communication and its use in realtime applications	Evaluate	1, 2	1, 2, 3, 4, 5, 9, 10, 12

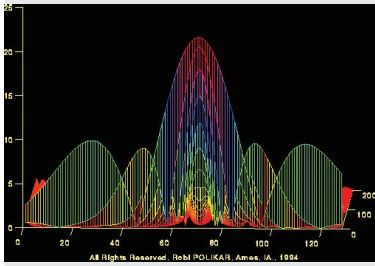
TEXT BOOKS:

1. Jeffrey H. Reed, “Software Radio: A Modern Approach to Radio Engineering”, 1st edition, Pearson Education, 2002.
2. C. Richard Johnson and Jr.William A. Sethares, “Telecommunication Breakdown”, Prentice Hall, 2003.

REFERENCES BOOKS:

1. K. Fazel and S. Kaiser, “Multi-carrier and Spread Spectrum Systems”, Wiley and Sons Publication, 2010.
2. e-learning: sdrforum.org.
3. Tools/Hardware for case study suggested: MATLAB/GNU Radio – SDR platforms suggested -HACK RF / WARP V3/ RTL SDR.

22EC960 WAVELET THEORY AND APPLICATIONS



Source: https://ccrma.stanford.edu/~unjung/mylec/WTpart1.html

Hours Per Week :

L	T	P	C
3	2	0	4

PREREQUISITES KNOWLEDGE: Basics of Digital signal processing.

COURSE DESCRIPTION AND OBJECTIVES:

The goal of this course is to build a grasp of the fundamental concepts of wavelets found in engineering. The methods for characterizing and analyzing continuous-time and discrete-time signals will be the primary focus. Students will learn transform techniques that will help them realize algorithms for signal and image processing applications like noise cancellation, compression and watermarking.

MODULE 1

UUNIT-1 **12L+8T+0P=20 Hours**

REVIEW OF STOCHASTIC SIGNALS AND TRANSFORMS:

Introduction: Review of stationary and non-stationary signals, Fourier transform, Heisenberg Uncertainty principle, short time Fourier transform, multi-rate signal processing-decimation, interpolation, quadrature mirror filter bank.

UNIT-2 **12L+8T+0P=20 Hours**

CONTINUOUS WAVELET TRANSFORM:

Continuous wavelet transform (CWT), Time and frequency resolution of the continuous wavelet transform, Zoom property of the continuous wavelet transform, Filtering in continuous wavelet, inverse CWT, Construction of continuous wavelets: Spline, orthonormal, bi-orthonormal, Classes of wavelets bases: Haar, biorthogonal, Daubechies, symlets, coiflets, shannnon, meyer.

PRACTICES:

- Identifying the stationarity of the real-world signals.
- Compute and plot the Fourier spectrum of signal.
- Use the short-time Fourier transform to plot the spectrum of the real-world signals.
- Wavelet properties, bases and their applications.

MODULE-2

UNIT-1 **12L+8T+0P=20 Hours**

DISCRETE WAVELET TRANSFORM:

Memory: Multiresolution formulation of wavelet systems- signal spaces, scaling function, wavelet function and its properties, Multiresolution analysis, Haar scaling and wavelet function, Wavelet basis for MRA, Filter banks- Analysis and Synthesis, 1D and 2D Discrete wavelet transform, inverse discrete wavelet transform, Wavelet Packets, Tree structured filter bank, filter bank implementation of two-dimensional wavelet transform..

UNIT-2 **12L+8T+0P=20 Hours**

APPLICATIONS:

Detection of signal changes, analysis and classification of audio signals using CWT, Wavelet based signal de-noising and energy compaction, Wavelets in adaptive filtering, Adaptive wavelet techniques in

SKILLS:

- ✓ *Understand the concept of wavelet transform and how well it can be used in nonstationary signal analysis.*
- ✓ *Learn different wavelet functions and their representations.*
- ✓ *Choose the appropriate wavelet function and filter structure for a given application.*
- ✓ *Apply transformation to real-world problems involving bio-signals.*

signal acquisition, coding and lossy transmission, Digital Communication and Multicarrier Modulation, Trans multiplexers , Image fusion, Edge Detection and object isolation

PRACTICES:

- Filter bank realization of Haar wavelet.
- Wavelet decomposition of real-time signals.
- Thresholding based denoising of signals.
- Image water marking using 2D wavelet transform.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Outline the various properties and Apply transform techniques on continuous and discrete time signals	Apply	1	1, 2, 4, 5, 9, 10, 12
2	Identify the wavelet function for analysing the target signal.	Apply	1	1, 2, 4, 5, 9, 10, 12
3	Analyse the frequency spectrum of continuous and discrete time signals.	Analyze	1,2	1, 2, 3, 5, 9, 10
4	Develop the algorithms for applications like noise cancellation and image watermarking.	Apply	2	1, 2, 4, 5, 9, 10, 12

TEXT BOOKS:

1. Wavelet Transforms –Introduction and applications - Raguveer M. Rao and Ajit S. Bopardikar-Pearson Education, 2008.
2. Fundamentals of Wavelets: Theory, Algorithms, and Applications, J.C. Goswami and A.K. Chan, 2nd ed., Wiley, 2011.

REFERENCE BOOKS:

1. A Wavelet Tour of Signal Processing, 2nd edition, S. Mallat, Academic Press, 1999.
2. Wavelets and Sub band Coding, M. Vetterli and J. Kovacevic, Prentice Hall, 1995.
3. Wavelets and their Applications, Michel Misiti, Yves Misiti, Georges Oppenheim, JeanMichel Poggi, John Wiley & Sons, 2010.
4. Wavelets : from math too practice, Desanka.P.Radunovik, springer, 2009.

HONOURS

ELECTRONICS AND COMMUNICATION ENGINEERING

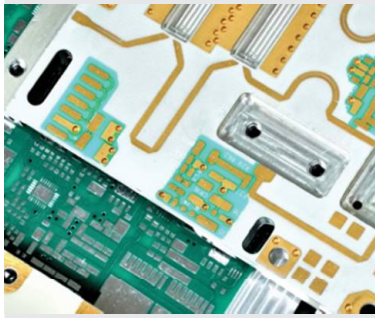
B.Tech.

22EC970	-	Applied RF Engineering I - Circuits and Transmission Line
22EC971	-	Microstrip and Printed Antenna Design
22EC973	-	Modeling and Simulation of Phased-Array Antennas
22EC974	-	RF Transceiver System Design

COURSE CONTENTS

I SEM & II SEM

22EC970 APPLIED RF ENGINEERING I-CIRCUITS AND TRANSMISSION LINE



Source: https://www.microwavejournal.com/articles/36671-rf-thermal-management-fabrication-methods-test

Hours Per Week :

L	T	P	C
3	2	0	4

PREREQUISITE KNOWLEDGE: Antenna Theory, Microwave Engineering.

COURSE DESCRIPTION AND OBJECTIVES:

The aim of the course is intended for students with an electromagnetic theory, Transmission line and microwave engineering background or equivalent practical experience. The covers covered is similar to the RF Technology.

MODULE –1

UNIT-1 **12L+8T+0P=20 Hours**

COMPLEX IMPEDANCE, RESONANCE, TRANSMISSION LINES:

Introduction-Frequency spectrum, Power levels at RF.

Complex Impedance, Resonance: Series RC, RL networks, Parallel RC, RL networks, Resonance, Q factor, conversion between series and parallel circuits

Transmission Lines: Transmission line types, characteristic impedance, lumped vs. distributed networks, short and open terminated transmission lines

Reflections: mismatch and reflections, reflection coefficient, return loss, mismatch loss, SWR.

UNIT-2 **12L+8T+0P=20 Hours**

SMITH CHART AND COMPONENT MANIPULATIONS:

Smith Chart, Derivation of impedance curves - resistance – reactance, admittance chart. Component Manipulations-Series Capacitor, Inductor, Resistor , Parallel Capacitor, Inductor, Resistor, Transmission lines

PRACTICES:

Design and verify the following design using Simulation Software (HFSS/ADS).

- Design RC, RL and parallel RC and RL circuits using ADS
- Design 50Ω transmission line using HFSS.
- Design Quarter wave transformer using HFSS.
- Analyze smith chart with suitable example.
- Calculate VSWR and Z parameter using HFSS.

MODULE-2

UNIT-1 **12L+8T+0P=20 Hours**

S-PARAMETERS:

S-parameters: comparison with Z, Y, ABCD parameters

Measurement: basic network analyzer block diagram

Cascaded Calculations: Cascaded S-parameters, T-parameters

Differential Circuits: Mixed mode S-parameters, Description of X-parameters

SKILLS:

- ✓ *Understanding the basic theory Complex Impedance, Resonance.*
- ✓ *Covers the Smith chart parameters.*
- ✓ *Covers the S parameters.*
- ✓ *Addresses the impedance matching circuits.*

UNIT-2 **12L+8T+0P=20 Hours**

IMPEDANCE MATCHING

Impedance Matching: Analytical Techniques using Q to Match Impedances, resonating reactances, Smith Chart, Component Models, Lumped Elements at RF, resistor component models, capacitor component models, inductor component models, behavior at high frequencies, package effect, ferrite behavior.

PRACTICES:

Design and verify the following design using Simulation Software (HFSS/ADS.

- Design Y parameter with suitable example using HFSS
- Design ABCD
- Design differential circuits using ADS.
- Design lumped element with suitable examples.
- Design quart wave transformer with suitable example.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply Series RC, RL networks, Parallel RC, RL network and calculate reflection coefficients.	Apply	1	1, 2, 4, 5, 9, 10, 12
2	Analysis of smith chart	Analysis	1	1, 2, 4,5, 9, 10,12
3	Analysis of S parameter and measurements	Analysis	2	1, 2,4,5, 9, 10,12
4	Analysis impedance matching	Analysis	2	1, 2,3,4,5, 9, 10, 12

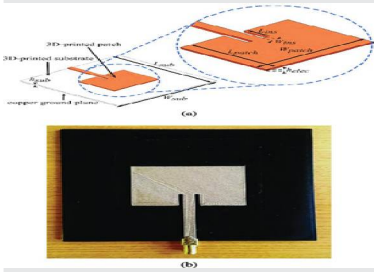
TEXT BOOKS:

1. Matthew N.O. Sadiku, “Elements of Electromagnetics”, 7th edition, Oxford Univ. Press, 2021.
2. William H. Hayt and John A. Buck, ‘Engineering Electromagnetics’, McGraw Hill Special Indian edition, 2014.

REFERENCES BOOKS:

1. Jordan, E.C. and Balmain, K.G., 1968. Electromagnetic waves and radiating systems. Prentice-Hall.
2. Kraus and Fleish, ‘Electromagnetics with Applications’, McGraw Hill International Editions, Fifth Edition, 2010
3. E.V.D. Glazier and H.R.L. Lamont, Transmission and Propagation, The Services Text Book of Radio, vol. 5, Standard Publishers Distributors, Delhi.
4. Joseph. A.Edminister, ‘Schaum’s Outline of Electromagnetics, Third Edition (Schaum’s Outline Series), McGraw Hill, 2010.

22EC971 MICROSTRIP AND PRINTED ANTENNA DESIGN



Source: https://www.researchgate.net/publication/334903778_Parametric_Study_of_3D_Additive_ Printing_Parameters_Using_Conductive_Filaments_on_Microwave_Topologies/figures?lo=1

Hours Per Week :

L	T	P	C
3	2	0	4

PREREQUISITE KNOWLEDGE: Antenna Theory.

COURSE DESCRIPTION AND OBJECTIVES:

The aim of this course is to introduce the concepts and fundamentals of microstrip antennas basic concept, different structure like, metamaterial, reconfigurable antenna, Fractal structure antenna, DRA antenna and design aspects.

MODULE - 1

UNIT-1 **12L+8T+0P=20 Hours**

BASICS OF MICROSTRIP ANTENNAS:

Origin of Microstrip radiators, microstrip antenna analysis methods, Rectangular microstrip patch antennas. Circular microstrip patch antennas.

UNIT-2 **12L+8T+0P=20 Hours**

METAMATERIALS:

The concept of Metamaterials: Basic Electromagnetic and Optical properties, Basic structures, potential applications, Governing equations for Metamaterials.

PRACTICES:

- Design Rectangular patch antenna for Bluetooth applications
- Design Zigbee antenna using insert feed techniques.
- Design Unit cell using HFSS
- Design metamaterial antenna for 5G applications
- Design metamaterial antenna for WLAN applications.

MODULE-2

UNIT-1 **12L+8T+0P=20 Hours**

RECONFIGURABLE ANTENNA:

Frequency reconfiguration methods: PIN diodes, Varactor Diodes, Liquid crystals, Graphene, Frequency reconfigurable slot antennas: Varactor loaded slot antenna, MIMO reconfigurable slot antenna.

UNIT-2 **12L+8T+0P=20 Hours**

DESIGN STRUCTURES AND APPLICATIONS OF DIFFERENT ANTENNAS:

Basic concepts of CPW-Coplanar Waveguide antennas, Fractal structure antenna, DRA-Dielectric Resonator Antennas, Micro strip antenna with DGS, Design structures of different antennas and applications of different antennas.

PRACTICES:

- Design reconfigurable antenna for WLAN and Bluetooth applications
- Design MIMO antenna using reconfigurable techniques.

SKILLS:

- ✓ *Select the required parameters to design different Microstrip patch Antennas.*
- ✓ *Identify the required microstrip Antennas for various Applications.*
- ✓ *Measure the antenna parameters and analyze the antenna performance.*

- Design CPW antenna for 5G applications.
- Design DRA for 5G applications
- Design DGS antenna for WLAN applications.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Analyze the basic rectangular and circular antenna.	Analyze	1	1, 2, 4, 5, 9, 10, 12
2	Analyze concept of metamaterial antenna.	Analyze	1	1, 2, 4,5, 9, 10,12
3	Analyze concept of reconfigurable antenna.	Analyze	2	1, 2,4,5, 9, 10,12
4	Analyze of different printed Antenna structures.	Analyze	2	1, 2,3,4,5, 9, 10, 12

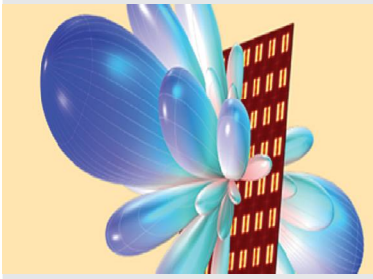
TEXT BOOKS:

1. Randy Bancraft, “Microstrip and Printed Antenna Design”,2nd Edition, Prentice-Hall of India, 2019.
2. Ramesh Garg, PrakashBhartia, InderBaul and ApisakIttipiboon, “Microstrip Antenna Design Handbook”, Artech House, 2018.

REFERENCE BOOKS:

1. A. Jichun Li, Yunqinghuang, “Time Domain Finite Element Methods for Maxwell’s equations in Metamaterials”, 2013
2. George tsoulos, “MIMO System Techonology for Wireless Communications”, 1st Edition
3. Jennifer T. Bernhard ,”Reconfigurable antennas”. 2007
4. Girish Kumar & KP Ray ,”Broadband microstrip antenna”, 2003.

22EC973 MODELING AND SIMULATION OF PHASED-ARRAY ANTENNAS



Source: https://www.comsol.com/blogs/how-to-synthesize-the-radiation-pattern-of-an-antenna-array/

Hours Per Week :

L	T	P	C
3	2	0	4

PREREQUISITE KNOWLEDGE: Antenna Theory.

COURSE DESCRIPTION AND OBJECTIVES:

The aim of this course is to introduce the concepts and fundamentals of phased array antennas basic concept, Side lobe level requirements, different array methods, feeding techniques, beam forming techniques, improvement in isolation and cross-polarizations techniques and their design aspects.

MODULE - I

UNIT-1 **12L+8T+0P=20 Hours**

ARRAY ANTENNA:

Introduction, pattern, Formulas for Arrays with Arbitrary element Positions, Linear Arrays, Schelkunoff's Unit Circle Representations.

UNIT-2 **12L+8T+0P=20 Hours**

ARRAY SYNTHESIS:

Introduction, Sum and difference patterns, Uniform Antenna Array synthesis, Dolph- chebyshev Synthesis, Taylor Synthesis, Bayliss synthesis, Binomial array synthesis.

PRACTICES:

Design and verify the following Antenna array using Simulation Software (HFSS/MATLAB).

- Generate Liner array antenna using MATLAB software.
- Calculation of side lobe suppression using HFSS.
- Generation of Dolph- chebyshev Synthesis using MATLAB software
- Generation of Taylor Synthesis using MATLAB software.
- Generation of Bayliss synthesis using MATLAB software

MODULE-2

UNIT-1 **12L+8T+0P=20Hours**

ARRAY FEEDING METHODS:

Series Feeding, Parallel Feeding or Corporate Binary Feeding Method, Differential Feeding method, Pair-wise Anti-Phase feeding method, Antenna Array Distribution Network.

UNIT-2 **12L+8T+0P=20 Hours**

ANTENNA ARRAY UNIT COMPONENTS:

Digital Attenuator, Digital Phase shifter, Circulator, Isolator, Dual Directional Coupler, T/R Switch.

PRACTICES:

Design and verify the following Antenna array using Simulation Software (HFSS/MATLAB).

- Generate circular Taylor using MATLAB software.
- Generation of circular grid arrays using HFSS.

SKILLS:

- ✓ *Knowing the basic theory of array antenna.*
- ✓ *Different synthesis for antenna array.*
- ✓ *Know the basic concept of array feeding methods.*
- ✓ *Focus on antenna array unit components.*

- Generation of Bayliss Difference Patterns for Circular Arrays MATLAB software
- Generation of Adaptive Arrays using MATLAB software.
- Generation of Multiple-Beam Arrays using MATLAB software

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Analyze the basic s of Array Antennas antenna	Analyze	1	1, 2, 4, 9, 10, 12
2	Analyze concept of phased array antenna.	Analyze	1	1, 2, 4, 9, 10,12
3	Analyze of different Array feeding methods	Analyze	2	1, 2,4,5, 9, 10,12
4	Analyze of antenna array unit components	Analyze	2	1, 2,3,4,5, 9, 10, 12

TEXT BOOKS:

1. Antenna Theory and Design, R.S. Elliott, Wiley. 2003.
2. Antenna for All Application, J.D.Krauss, R.J.Marhefka and Ahmad.S.Khan Tata McGraw Hill Publishing Company Ltd, Third Edition, 2006.

REFERENCE BOOKS:

1. Mailloux, R.J., 2017. Phased array antenna handbook. Artech house.
2. Constantain A Balanis, “Antenna Theory: Analysis and Design”, 4th edition, Wiley Publishers, 2015.

22EC974 RF TRANSCEIVER SYSTEM DESIGN

Source: https://rahsoft.com/courses/receiver-transmitter-and-transceiver-architectures-rf-design-online-course-rahrf409rf-system-design-of-receivers-transmitters-transceivers/

Hours Per Week :

L	T	P	C
3	2	0	4

PREREQUISITE KNOWLEDGE: Microwave Engineering.

COURSE DESCRIPTION AND OBJECTIVES:

This course helps to understand the basics of RF Filter, active components and circuits. This makes that student able to design of amplifier, oscillator and mixer circuit. With help of RF CAD software (ADS) students can able to perform it.

MODULE-1

UNIT-1 **12L+8T+0P=20 Hours**

RF FILTER DESIGN:

Overview, Basic resonator and filter configuration, special filter realizations, smith chart based filter design, coupled filter.

UNIT-2 **12L+8T+0P=20 Hours**

ACTIVE RF COMPONENTS AND APPLICATIONS:

RF diodes, BJT, RF FET'S, High electron mobility transistors, matching and biasing networks- impedance matching using discrete components, microstripline matching networks, amplifier classes of operation and biasing networks.

PRACTICES:

Design and verify the following RF Passive Circuit using Simulation Software (HFSS/MATLAB).

- Generate of S parameter using MATLAB software.
- Design of Microstrip line using HFSS.
- Design of impedance matching circuit using ADS
- Design of Stubs using HFSS
- Design of Matching network design using Lumped elements- RC, RL, RLC using ADS

MODULE-2

UNIT-1 **12L+8T+0P=20 Hours**

RF AMPLIFIER DESIGNS:

Characteristics, amplifier power relations, stability considerations, constant gain circles, constant VSWR circles, low noise circles broadband, high power and multistage amplifiers.

UNIT-2 **12L+8T+0P=20 Hours**

OSCILLATORS, MIXERS & APPLICATIONS:

Basic oscillator model, High Frequency oscillator configuration, basic characteristic of mixers, wireless synthesizers, phase locked loops, detector and demodulator circuits.

PRACTICES:

Design and verify the following RF Passive Circuit using Simulation Software (HFSS/MATLAB).

SKILLS:

- ✓ *Understanding the basic of RF filter.*
- ✓ *Analysis of Active RF components and applications.*
- ✓ *Analysis of RF amplifier.*
- ✓ *Focus on oscillator and mixer applications.*

- Generate of Wilkinson Power divider using HFSS software.
- Design of 90° Hybrids, Branch line couplers using HFSS.
- Design of Branch line couplers using HFSS
- Design of phase shifter using ADS
- Design of RF filter using ADS

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply and design of RF filter	Apply	1	1, 2, 4, 5, 9, 10, 12
2	Design and analyze the performance parameters of RF components	Analyze	1	1, 2, 4,5, 9, 10,12
3	Design and analyse of RF Amplifier	Analyze	2	1, 2,4,5, 9, 10,12
4	Design and analyze RF oscillator and Mixer.	Anlayze	2	1, 2,3,4,5, 9, 10, 12

TEXT BOOKS:

1. D M Pozar, Microwave Engineering, John Wiley & Sons, 2011
2. Gonzalez, Guillermo, Microwave transistor amplifiers: analysis and design, Prentice hall ,2010.

REFERENCE BOOKS:

1. Chang K, Bahl I and Nair V, “RF and Microwave Circuit and Component Design for Wireless Systems”, Wiley Inter science. 2002
2. Reinhold Ludwig, Pavel Bretchko, “RF Circuit Design: Theory and Applications”, Prentice Hall, Year: 2000.ISBN: 0130953237.
3. Qizheng Gu, “RF System Design of Transceivers for Wireless Communications”, Springer, 2005.

MINORS

ELECTRONICS AND COMMUNICATION ENGINEERING

B.Tech.

22EC901	-	ADHOC Sensor Networks
22EC902	-	Design Principles of IoT
22EC903	-	Introduction to Internet of Things
22EC904	-	Introduction to IoT Architecture
22EC905	-	Machine Learning for IoT Systems
22EC906	-	Security Aspects of IoT
22EC907	-	Sensors and Actuators for IoT

COURSE CONTENTS

I SEM & II SEM

22EC901 ADHOC SENSOR NETWORKS

Source: https://www.brainkart.com/subject/Ad-hoc-and-Wireless-Sensor-Networks_363/

Hours Per Week :

L	T	P	C
3	0	2	4

PREREQUISITE KNOWLEDGE: Basics of computer networks.

COURSE DESCRIPTION AND OBJECTIVES:

This course is aimed at offering fundamental concepts of wireless ad-hoc networks and wireless sensor networks. Explore the various MAC routing protocols and their importance for designing of energy efficient and reliable wireless networks.

MODULE–1

UNIT-1 **12L+0T+8P=20hours**

INTRODUCTION AND ROUTING PROTOCOLS:

Introduction to Ad Hoc Networks - Fundamentals of Wireless Communication Technology The Electromagnetic Spectrum – Radio propagation Mechanisms – Characteristics of the Wireless Channel -mobile ad hoc networks (MANETs) and wireless sensor networks (WSNs) :concepts and architectures. Applications of Ad Hoc and Sensor networks. Design Challenges in Ad hoc and Sensor Networks.

UNIT-2 **12L+0T+8P=20hours**

MAC PROTOCOLS FOR ADHOC WIRELESS NETWORK:

Issues in designing a MAC Protocol- Classification of MAC Protocols- Contention based protocols Contention based protocols with Reservation Mechanisms- Contention based protocols with Scheduling Mechanisms – Multi channel MAC-IEEE 802.11

MODULE-2

UNIT-1 **12L+0T+8P=20hours**

SENSOR NETWORKS – INTRODUCTION & ARCHITECTURES:

Challenges for Wireless Sensor Networks, Enabling Technologies for Wireless Sensor Networks, WSN application examples, Single Node Architecture – Hardware Components, Energy Consumption of Sensor Nodes, Network Architecture – Sensor Network Scenarios, Transceiver Design Considerations, Optimization Goals and Figures of Merit.

UNIT-2 **12L+0T+8P=20hours**

WSN NETWORKING CONCEPTS AND PROTOCOLS:

MAC Protocols for Wireless Sensor Networks, Low Duty Cycle Protocols and Wakeup Concepts – S MAC, The Mediation Device Protocol, Contention based protocols – PAMAS, Schedule based protocols – LEACH, IEEE 802.15.4 MAC protocol, Routing Protocols, Energy Efficient Routing, Challenges, and Issues in Transport layer protocol.

PRACTICES:

Experiments to be carried out in any network simulator like NETSIM, NS2 and OMNET++ etc.

- Examine the various path loss models available for wireless networks
- Identify the various reasons for hidden node terminal problem in wireless ad-hoc networks.

SKILLS:

- ✓ *Identify the various issues and their solutions in for designing wireless networks*
- ✓ *Implement routing algorithms for ad-hoc and sensor networks.*
- ✓ *Develop wireless sensor networks with respect to some protocol design issues.*

- Create a scenario where both ad-hoc and wireless sensor network are available and examine the interference problem.
- Simulate the MAC routing protocols for wireless sensor networks.
- Simulate the multiple wireless scenarios for throughput performance.
- Analyze performance of the MANET routing protocols in various parameters like end-to-end delay, bit error rate and throughput.
- Design a wireless sensor network and observe how the power consumption consumed for the network.
- Examine the importance of channel accessing mechanism helped for getting high throughput in wireless networks.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Realize concepts, network architectures and applications of ad hoc and wireless sensor networks	Create	1	1, 2, 4, 9, 10, 11, 12
2	Analyze the protocol design issues of ad hoc and sensor networks	Analyze	1	1, 2, 3, 4, 9, 10, 11, 12
3	Design routing protocols for ad hoc systems.	Create	2	1, 2, 3, 4, 9, 10, 11, 12
4	Evaluate the QoS related performance measurements of ad hoc and sensor networks	Evaluate	2	1, 2, 3, 4, 9, 10, 11, 12

TEXTBOOKS:

1. Carlos Corderio Dharma P. Aggarwal, “Ad-Hoc and Sensor Networks – Theory and Applications”, World Scientific Publications, March 2011.
2. Holger Karl and Andreas Willig “Protocols and Architectures for Wireless Sensor Networks”, “Wiley”, 2005.

REFERENCEBOOKS:

1. C. Siva Ram Murthy and B. S. Manoj, “Ad Hoc Wireless Networks Architectures and Protocols”, Prentice Hall, PTR, 2004.
2. Kazem sohraby, Daniel Minoli and Taieb Znati, “Wireless Sensor Networks: Technology, Protocols and Application” John Wiley, 2007.
3. C.K Toh, “Ad-Hoc Mobile Wireless Networks: Protocols and Systems” 1st edition, Pearson, 2007.

22EC902 DESIGN PRICIPLES OF IOT

Source: https://embeddedcomputing.com/technology/iot/device-management/key-areas-to-focus-while- developing-connected-app-for-iot-solutions

Hours Per Week :

L	T	P	C
3	0	2	4

PREREQUISITE KNOWLEDGE: Introduction to IoT.

COURSE DESCRIPTION AND OBJECTIVES:

This course emphasis on the design principles for developing an IoT product in the market. The objective of the course is to enable the students to understand the design principles while prototyping the IoT devices.

MODULE –1

UNIT-1 **8L+0T+8P=16 Hours**

DESIGN PRINCIPLES FOR CONNECTED DEVICES:

Introduction, Design Principles for Connected Devices, Calm and Ambient Technology, Magic as Metaphor, Privacy, Web Thinking for Connected Devices, Affordances.

UNIT-2 **12L+0T+8P=20hours**

PROTOTYPING EMBEDDED DEVICES;

Thinking About Prototyping: Sketching, Familiarity, Costs versus Ease of Prototyping, Prototypes and Production, Open Source versus Closed Source, Tapping into the Community.

Prototyping Embedded Devices: Electronics, Embedded Computing Basics, Arduino, Raspberry Pi, BeagleBone Black, Electric Imp, Other Notable Platforms

PRACTICES:

- Sense the available networks using Arduino.
- Detect the vibration of an object using Arduino.
- Connect with the available wi-fi using Arduino.

MODULE-2

UNIT-1 **12L+0T+8P=20hours**

PROTOTYPING ONLINE COMPONENTS;

Prototyping Online Components: Getting Started with an API, Writing a New API, Real-Time Reactions, Other Protocols

Techniques for Writing Embedded Code: Memory Management, Performance and Battery Life, Libraries, Debugging

UNIT-2 **12L+0T+8P=20hours**

FROM PROTOTYPE TO REALITY:

Business Models, Lean Start-ups, Moving to Manufacture, Designing Kits, Designing Printed circuit boards, Manufacturing Printed Circuit Boards, Ethics, Privacy, Control.

PRACTICES:

- Data Logging with Raspberry pi and Thing speak.
- Turn your smartphone into an IoT device.

SKILLS:

- ✓ *Design prototypes for IoT applications.*
- ✓ *Able to understand the design principle for IoT.*
- ✓ *Interface I/O devices with APIs*

- Interfacing Arduino with any cloud platform.
- Measure any physical quantity and tweet when it crossed the threshold limit.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Understand the design principles for connected devices.	Apply	1	1, 2,3,5
2	Able to design the framework necessary for IoT applications	Apply	1	1, 2,3,5, 12
3	Develop prototypes for IoT devices	Apply	1	1, 2, 3, 5, 12
4	Develop APIs for IoT applications.	Apply	2	1, 2, 3,12
5	Design business models for IoT.	Apply	2	1, 2, 3

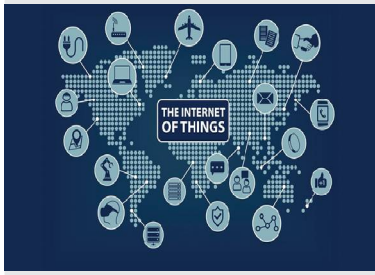
TEXT BOOKS:

1. Adrian McEwen, “Designing the Internet of Things”, Wiley Publishers, 2013.
2. Kamal R. Internet of Things, McGraw Hill, 2017.

REFERENCES BOOKS:

1. Perry Lea, “Internet of Things for Architects”, 1st edition, Packt Publishing, 2018.
2. Samuel Greengard, “The Internet of Things (Essential Knowledge)”, MIT Press, 2015.
3. Timothy Chou, Precision: Principles, Practices and Solutions for the Internet of Things, Cloudbook Inc., USA. April-13 2020.

22EC903 INTRODUCTION TO INTERNET OF THINGS



Source: https://www.freecodecamp.org/news/introduction-to-iot-internet-of-things/

Hours Per Week :

L	T	P	C
3	0	2	4

PREREQUISITE KNOWLEDGE: Basic knowledge of internet.

COURSE DESCRIPTION AND OBJECTIVES:

This course offers skills on interconnection and integration of the physical world and the cyberspace. The objective of the course is to enable the students to design and develop IoT systems for real-world problems.

MODULE-1

UNIT-1 **12L+0T+8P=20 Hours**

IOT INTRODUCTION & CONCEPTS:

Introduction: Definition and Characteristics of IoT, Physical Design of IoT, Logical Design of IoT, IoT Enabling Technologies, IoT Levels and deployment.

UNIT-2 **12L+0T+8P=20 Hours**

PROTOTYPING & APPLICATIONS:

Prototyping Embedded Devices: Electronics, Embedded Computing Basics, Arduino, ESP8266, Raspberry Pi.

Domain Specific Applications of IoT: Home Automation, Cities, Environment, Energy, Retail, Logistics, Agriculture, Industry, Health & Life Style.

PRACTICES:

- Familiarization with Arduino boards and ESP8266.
- Interfacing of LED and switch with Arduino boards and ESP8266.
- Traffic Light control using Arduino board and ESP8266.
- Interfacing DHT11 sensor with Arduino board and ESP8266.
- Interfacing of ultrasonic sensor with Arduino board and ESP8266.
- Interfacing of PIR sensor with Arduino board and ESP8266.
- DC motor control using L293D motor driver and Arduino board.

MODULE-2

UNIT-1 **12L+0T+8P=20 Hours**

INTERNET PRINCIPLES & M2M:

Internet Principles: Internet communications: An overview, IP addresses, MAC addresses, TCP and UDP ports, Application layer protocols; Python packages of interest for IoT.

M2M: Introduction to M2M, M2M architecture, Difference between IoT and M2M, SDN and NFV for IoT.

UNIT-2 **12L+0T+8P=20 Hours**

IOT DESIGN:

IoT Design: IoT Design Methodology, Python Web Application Framework, Django, Designing a REST full web API.Case Studies: Home Automation, Smart Cities, Environment, Agriculture, Productivity Applications.

SKILLS:

- ✓ *Use various sensors and actuators for IoT applications.*
- ✓ *Interface programming on I/O devices.*
- ✓ *Develop applications for the Internet of things.*

PRACTICES:

- Familiarization with Raspberry pi.
- Interfacing of LED and switch with Raspberry pi.
- Interfacing PIR sensor with Raspberry pi.
- Interfacing DHT11 sensor with Raspberry pi.
- Interfacing of ultrasonic sensor with Raspberry pi.
- Interfacing of Picam with Raspberry pi.
- Sending email with Raspberry pi.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Interface sensors with various embedded devices.	Apply	1	1, 2,5,12
2	Design the framework necessary for IoT applications	Apply	1	1, 2, 5, 12
3	Develop prototypes for IoT devices	Apply	1	1, 2, 3, 5, 12
4	Assess various internet principles and M2M technologies.	Apply	2	1, 2, 12
5	Classify various advanced IoT applications and case studies.	Apply	2	1, 2

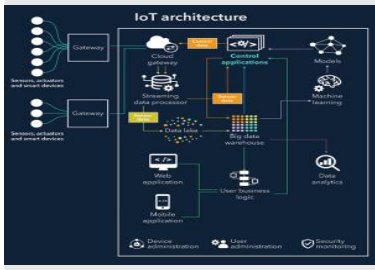
TEXT BOOKS:

1. Vijay Madisetti, Arshdeep Bahga, “Internet of Things A Hands-On- Approach”, 2014.
2. Adrian McEwen, “Designing the Internet of Things”, Wiley Publishers, 2013.

REFERENCE BOOKS:

1. Perry Lea, “Internet of Things for Architects”, 1st edition, Packt Publishing, 2018.
2. Samuel Greengard, “The Internet of Things (Essential Knowledge)”, MIT Press, 2015.
3. Timothy Chou,. Precision: Principles, Practices and Solutions for the Internet of Things, Cloudbook Inc., USA. April-13 2020.

22EC904 INTRODUCTION TO IOT ARCHITECTURE



Source: https://www.scnsoft.com/blog/iot-architecture-in-a-nutshell-and-how-it-works

Hours Per Week :

L	T	P	C
3	0	2	4

PREREQUISITE KNOWLEDGE: Introduction to IoT.

COURSE DESCRIPTION AND OBJECTIVES:

This course introduces the Architecture of IoT, basic concepts of IoT architectures and IoT Levels. The Course emphasizes the constraints, requirements, and architectures of hardware and software components for IoT systems. By the end of the course, a student will be able to: (1) Develop IoT solutions based on popular hardware/software platforms to address real-life problems (2) Evaluate the cost, power, and performance trade-offs associated with IoT solutions

MODULE - 1

UNIT-1 **12L+0T+8P=20hours**

IOT REFERENCE MODELS:

Introduction: Introduction to IoT, Applications of IoT, Use cases of IoT, The IoT Architectural Reference Model as Enabler,

IoT in Practice: Examples: IoT in Logistics and Health, IoT Reference Model: Domain, information, functional & communication models.

UNIT-2 **12L+0T+8P=20hours**

IOT ARCHITECTURE AND PROTOCOLS:

IoT Reference Architecture: Architecture, Functional, information, deployment and operation views; SOA based Architecture, API-based Architecture, OPENIoT Architecture for IoT/Cloud Convergence.

Application Protocols for IoT: UPnP, CoAP, MQTT, XMPP. SCADA, WebSocket; IP-based protocols: 6LoWPAN, RPL; Authentication Protocols; IEEE 802.15.4.

Case study: Cloud-Based Smart-Facilities Management, Healthcare, Environment Monitoring System.

PRACTICES:

- Implementation of home automation system using relay module.
- Implementation of traffic signal control using 6LoWPAN.
- Implementation of railway gate control by stepper motors.
- Direction and speed control of DC Motor.
- Familiarization with Arduino/Raspberry pi .
- To interface LED/Buzzer with Arduino/Raspberry Pi and write a program to turn on led for 1sec after every 2 seconds.
- Write a program on Arduino/Raspberry Pi to publish temperature data to the MQTT broker.
- Write a program on Arduino/Raspberry Pi to subscribe to the MQTT broker for temperature data and print it.

MODULE-2

UNIT-1 **12L+0T+8P=20hours**

IOT REFERENCE ARCHITECTURE:

IIoT Architecture: The IIC Internet Reference Architecture, Industrial Internet Architecture Framework (IIAF), Architectural Topology, The Three-Tier Topology, Connectivity, Key System Characteristics, Data Management.

SKILLS:

- ✓ *Understand the specifications and how well different components work together for IoT Boards.*
- ✓ *Learn different data and number representations.*
- ✓ *Design ALU and Control unit.*
- ✓ *Identify the types of IoT application protocols and their uses.*
- ✓ *To enable the students to take up the real-time industry as well as interdisciplinary projects.*

UNIT-2 **12L+0T+8P=20hours**

DESIGNING INDUSTRIAL INTERNET SYSTEMS:

The Concept of the IIoT, The Proximity Network, WSN Edge Node, Legacy Industrial Protocols, Modern Communication Protocols, Wireless Communication Technologies, Proximity Network Communication Protocols, Gateways Examining the Access Network Technology and Protocols - The Access Network, Access Networks Connecting Remote Edge Networks

PRACTICES:

- Identify the industrial Sensors
- Interfacing raspberry pi with Boilers
- Implementation of scrolling belt using raspberry pi.
- implementation of the network using raspberry pi.
- To interface Bluetooth with Arduino/Raspberry Pi and write a program to send sensor data to the smartphone using Bluetooth.
- To interface node MCU with Arduino/Raspberry Pi and write a program to send sensor data to the smartphone using Blynk Application/Cloud.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Build the IoT Design with sensors and actuators and analyse the levels of Arduino programming language.	Apply	1	1, 2, 12
2	Make use of sensors for collection data from the physical medium	Apply	1	1, 2, 5, 12
3	Apply the physical layer issues, analyse Medium Access Control Protocols/IoT Protocols	Apply	1	1, 2, 3, 5, 12
4	Categorize various topologies and Data management tools	Analyze	2	1, 2, 12
5	Comprehend network and transport layer characteristics and protocols and implement conventional protocols	Analyze	2	1, 2

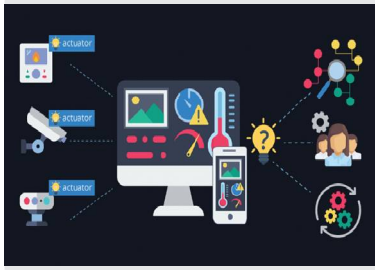
TEXT BOOKS:

1. Giacomo Veneri; Antonio Capasso, “Hands-on Industrial Internet of Things : create a powerful Industrial IoT infrastructure using Industry 4.0”, ,Packt Publishing, 2018
2. Vijay Madisetti, ArshdeepBahga,” Internet of Things A Hands-On- Approach”,2014

REFERENCE BOOKS:

1. Bassi, Alessandro, et al, “Enabling things to talk”, Springer-Verlag Berlin An, 2016.
2. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry, “IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things”, CISCO Press, 2017
3. Hersent, Olivier, David Boswarthick, and Omar Elloumi. The internet of things: Key applications and protocols. John Wiley & Sons, 2011.
4. Buyya, Rajkumar, and Amir Vahid Dastjerdi, eds. Internet of Things: Principles and paradigms. Elsevier, 2016
5. Alasdair Gilchrist,“Industry 4.0: The Industrial Internet of Things” by, ISBN: 978-1-4842-2046-7, APRESS, 2016.
6. Francis daCosta, “Rethinking the Internet of Things: A Scalable Approach to ConnectingEverything”, 1 st Edition, Apress Publications, 2013

22EC905 MACHINE LEARNING FOR IOT SYSTEMS



Source: https://www.scnsoft.com/blog/iot-systems-classification

Hours Per Week :

L	T	P	C
3	0	2	4

PREREQUISITE KNOWLEDGE: Introduction to IoT.

COURSE DESCRIPTION AND OBJECTIVES:

Machine learning can help demystify the hidden patterns in IoT data by analyzing massive volumes of data using sophisticated algorithms. Machine learning inference can supplement or replace manual processes with automated systems using statistically derived actions in critical processes. Machine learning for IoT to perform predictive capabilities on a wide variety of use cases that enable the business to gain new insights and advanced automation capabilities.

MODULE–1

UNIT-1 **9L+0T+6P=15 Hours**

INTRODUCTION:

Introduction to Internet of Things –Definition and Characteristics of IoT, Physical Design of IoT – IoT Protocols, IoT communication models, IoT Communication APIs, IoT enabaled Technologies – Wireless Sensor Networks, Cloud Computing, Big data analytics, Communication protocols, Embedded Systems, IoT Levels and Templates.

UNIT-2 **15L+0T+10P=25 Hours**

Domain Specific IoTs – Home, City, Environment, Energy, Retail, Logistics, Agriculture, Industry, health and Lifestyle

M2M to IoT- An Architectural Overview– Building an architecture, Main design principles and needed capabilities, An IoT architecture outline, standards considerations.

PRACTICES:

- Establish a sense of relationship of all variables with one other in IRIS dataset. (Multivariate Analysis).
- Analyse individual variables for better understanding using IRIS dataset. (Univariate Analysis).
- Linear regression for Housing data set to predict the price of the house.

MODULE-2

UNIT-1 **9L+0T+6P=15 Hours**

INTRODUCTION TO MACHINE LEARNING:

Definition of learning systems. Goals and applications of machine learning, Supervised Learning, Unsupervised Learning, Bias-variance trade-off, Overfitting, under fitting, Gradient descent: -batch, stochastic, Model Evaluation, trees and ensembles, Support vector machines, Working with Text Data

UNIT-2 **15L+0T+10P=25 Hours**

AUTOMATION SYSTEMS USING ML AND IOT:

Analysis of systems using ML and IoT- Data collection, data processing and Analysis- CCTV data analysis, smart cities, smart fish system etc

PRACTICES:

- Implement k-nearest neighbour algorithm to classify the iris data set. Print both correct and

SKILLS:

- ✓ *Ingest and transform data into a consistent format*
- ✓ *Work with various communication technologies and sensors*
- ✓ *Build a machine learning model*
- ✓ *Apply a appropriate ML algorithm to a specific task*
- ✓ *Deploy this machine learning model on cloud, edge and device*

wrong predictions.

- Use appropriate data set for building the decision tree and apply this knowledge to classify a new sample.
- Splitting the data into training and test data sets using K-fold cross-validation
- Regression problems using XGBoost.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Analyse concise manner how the general Internet as well as Internet of Things work.	Analyse	1	1, 2, 3, 4, 9, 10, 11, 12
2	Analyse constraints and opportunities of wireless and mobile networks for Internet of Things.	Analyse	1	1, 2, 3, 4, 9, 10, 11, 12
3	Evaluate various Ml algorithms to various applications	Evaluate	2	1, 2, 3, 4, 9, 10, 11, 12
4	Analyse various IoT based smart systems.	Apply	2	1, 2, 3, 4, 9, 10, 11, 12

TEXT BOOKS:

1. Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle, “From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence”, 1st Edition, Academic Press, 2014.
2. Introduction to Statistical Learning by Gareth James, Daniela Witten, Trevor Hastie and Robert Tibshirani. Springer, 2013. Corrected 8th printing, 2017

REFERENCE BOOKS:

1. Vijay Madisetti and Arshdeep Bahga, “Internet of Things (A Hands-on-Approach)”, 1stEdition, VPT, 2014.
2. Francis daCosta, “Rethinking the Internet of Things: A Scalable Approach to Connecting Everything”, 1st Edition, Apress Publications, 2013.
3. Ammar Rayes, Samer Salam, “Internet of Things from Hype to Reality”, Springer, 2022.

22EC906 SECURITY ASPECTS OF IOT

Source: https://www.wsj.com/articles/BL-CIOB-8241

Hours Per Week :

L	T	P	C
3	0	2	4

PREREQUISITE KNOWLEDGE: Introduction to Internet of Things.

COURSE DESCRIPTION AND OBJECTIVES:

This course introduces the methodologies of Cyber Physical systems and the basic Trust models of IoT. The course explores on different threads on IoT applications and provides privacy preservation for real time data using Attack detection techniques, Encryption, Hash Function, Elliptic curves, Signature Algorithms, Consensus Algorithms and Secured Access Protocols.

MODULE–1

UNIT-1 **12L+0T+8P=20 Hours**

CYBER PHYSICAL SYSTEMS & THREADS:

Introduction to IoT –Cyber Physical Systems: IoT and cyber-physicalsystems, IoT security (vulnerabilities, attacks, and countermeasures), security engineering for IoT development, IoT security lifecycle.

IoT as Interconnection of Threats: Network Robustness of Internet of Things- Sybil Attack Detection in Vehicular Networks- Malware Propagation and Control in Internet of Things- Solution-Based Analysis of Attack Vectors on Smart Home Systems

UNIT-2 **12L+0T+8P=20 Hours**

CRYPTO FOUNDATIONS & BLOCK CHAIN:

Crypto Foundations: Block ciphers, message integrity, authenticated encryption, hash functions, Merkle trees, elliptic curves, public-key crypto (PKI), signature algorithms

Block Chain: Crypto-currencies, Bitcoin P2P network, distributed consensus, incentives and proof-of-work, mining, script and smart contracts, wallets: hot and cold storage, anonymity, altcoins.

PRACTICES:

- Implement Block Cipher Encryption.
- Analyze Attacks on smart Home
- Vulnerabilities on IoT devices.
- Implement attacks on IoT.
- Evaluate Cyber-physical systems.
- Design smart contract for real time IoT applications.
- Implement Consensus Algorithm for IoT.
- Implement Sybil Attack Detection.
- Implement Malware Control in Internet of Things.
- Implement elliptic curve cryptography.

MODULE-2

UNIT-1 **12L+0T+8P=20 Hours**

PRIVACY PRESERVATION & TRUST MODELS:

Privacy Preservation for IoT: Privacy Preservation Data Dissemination- Privacy Preservation Data Dissemination- Social Features for Location Privacy Enhancement in Internet of Vehicles- Lightweight

SKILLS:

- ✓ *Understands the state-of-the-art methodologies in Cyber Physical system.*
- ✓ *Knowledge on Model threats and countermeasures.*
- ✓ *Explores the Privacy Preservation and Trust Models in Internet of Things (IoT)*
- ✓ *Designs Internet of Things Security in the real world scenarios*

and Robust Schemes for Privacy Protection in Key Personal IoT Applications: Mobile WBSN and Participatory Sensing

Trust Models for IoT: Authentication in IoT- Computational Security for the IoT- Privacy-Preserving Time Series Data Aggregation- Secure Path Generation Scheme for Real-Time Green Internet of Things- Security Protocols for IoT Access Networks- Framework for Privacy and Trust in IoT- Policy-Based Approach for Informed Consent in Internet of Things

UNIT-2 **12L+0T+8P=20 Hours**

INTERNET OF THINGS SECURITY:

Security and Impact of the Internet of Things (IoT) on Mobile Networks- Networking Function Security- IoT Networking Protocols, Secure IoT Lower Layers, Secure IoT Higher Layers, Secure Communication Links in IoTs, Back-end Security -Secure Resource Management, Secure IoT Databases, Security Products-Existing Test bed on Security and Privacy of IoTs, Commercialized Products.

PRACTICES:

- Implement IoT Networking protocols.
- Implement authorized login for IoT database.
- Secured IoT Access Networks.
- Security implementation at Lower Layers.
- Security implementation at Higher Layers.
- Design light weight security applications.
- Design policy for IoT data Approach.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Identify the areas of cyber security for the Internet of Things.	Analyze	1	1, 2
2	Assess different Internet of Things technologies and their applications.	Analyze	1	1, 2, 12
3	Model IoT to business	Apply	1	1, 2, 3, 5
4	Customize real time data for IoT applications.	Apply	2	1, 2, 12
5	Solve IoT security problems using light weight cryptography	Analyze	2	1, 2, 3, 5
6	Build security systems using elementary blocks	Apply	2	1, 2, 3, 5

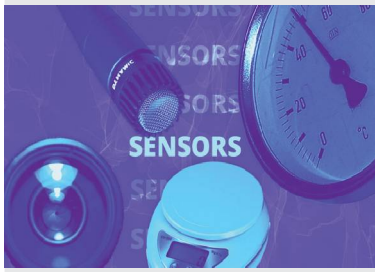
TEXT BOOKS:

1. Hu, Fei. Security and privacy in Internet of things (IoTs): Models, Algorithms, and Implementations, 1 st edition,CRC Press, 2016.
2. Russell, Brian, and Drew Van Duren. Practical Internet of Things Security, 1 st edition, Packt Publishing Ltd, 2016.

REFERENCE BOOKS:

1. Whitehouse O. Security of things: An implementers' guide to cyber-security for internet of things devices and beyond, 1 st edition, NCC Group, 2014
2. DaCosta, Francis, and Byron Henderson. Rethinking the Internet of Things: a scalable approach to connecting everything, 1 st edition, Springer Nature, 2013.
3. Patel Chintan, Nishant Dosji. Internet of Things Security Challenges, Advances and Analysis, 1st Edition, Auerbach, 2018.

22EC907 SENSORS AND ACTUATORS FOR IOT



Source: https://www.iotforall.com/an-introduction-to-iot-sensors

Hours Per Week :

L	T	P	C
3	0	2	4

PREREQUISITE KNOWLEDGE: Introduction to IoT or Embedded Systems.

COURSE DESCRIPTION AND OBJECTIVES:

Explore IoT smart sensor and actuator solutions. Compare types and technical requirements and protocols across market industries. Develop solutions for IoT using various sensors and actuators.

MODULE - I

UNIT-1 **12L+0T+8P=20 Hours**

INTRODUCTION TO SENSORS & ACTUATORS:

Definitions, Classification of sensors and Actuators, General Requirement for interfacing, Units.

Input output characteristics, Transfer function, Range, Span, input and Output full scale, resolution and dynamic range, accuracy, errors, and repeatability, sensitivity and sensitivity analysis, hysteresis, nonlinearity, and saturation, Frequency response, response time, and bandwidth, Calibration, excitation, deadband, reliability.

UNIT-2 **12L+0T+8P=20 Hours**

PRINCIPLES OF SENSORS:

Principles of sensing (Basics) : Capacitance, Magnetism, Resistance, Induction, Piezoelectric effect, Hall effects, Thermoelectric Effects

Ultrasonic Detectors, Optoelectronic Motion Detectors, Optical Presence Sensors, Pressure-Gradient Sensors, 2-D Pointing Devices, Gesture Sensing (3-D Pointing), Tactile Sensors

PRACTICES:

- Find the input characteristics of capacitive sensors
- Measure the range, sensitivity hysteresis, nonlinearity of temperature sensors
- Measure the frequency response of temperature sensor
- Measure the range of optical sensors and calibrate its use for displacement measurement.
- Calibrate a hall effect sensor
- Measure the displacement range, linearity, frequency response of piezoelectric sensor
- Measure the sensitivity of resistance sensors and establish their input characteristics
- Establish sensitivity, range, linearity and frequency response of tactile sensors.

MODULE-2

UNIT-1 **12L+0T+8P=20 Hours**

INTERFACING ELECTRONICS FOR SENSORS:

Signal Conditioners: Input Characteristics, Amplifiers, Operational Amplifiers, Voltage Follower, Charge- and Current-to-Voltage Converters, Light-to-Voltage Converters, Capacitance-to-Voltage Converters, Closed-Loop Capacitance-to-Voltage Converters

Data Acquisition: Data Acquisition, Sensor Classification, Units of Measurements

Analog-to-Digital Converters: Basic Concepts, Digital to analog converters, V/F Converters, PWM Converters, R/F Converters, Successive-Approximation Converter, Resolution Extension, ADC Interface

SKILLS:

- ✓ *Use various sensors and actuators for IoT applications.*
- ✓ *Interface programming on I/O devices.*
- ✓ *Develop applications for the Internet of things.*

UNIT-2 **12L+0T+8P=20 Hours**

ACTUATORS & INTERFACING:

Thermal actuators, Optical actuators, Capacitive actuators, Magnetic actuators, magnetrostrictive actuators, Acoustic actuators, Electromagnetic actuators (DC, Stepper motors) and their control principles

Interfacing to microprocessor/microcontrollers. Microprocessor as general-purpose controller, General requirements for interfacing sensors and actuators. Interfacing examples

PRACTICES:

- Develop signal conditioning circuit for low level signals along with noise removal
- Develop a digital circuit for amplification of the capacitive sensor and establish various characteristics.
- Develop a digital circuit for measuring the optical sensitivity of optical sensor
- Control the rotation of stepper motor to precise angle without any sensors
- Tracking object by controlling servo motor precisely

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Identify sensors for selection of a specific physical parameter	Apply	1	1, 2, 12
2	Interface the sensor with different data acquisition systems	Create	2	1, 2, 5, 12
3	Control various actuators	Apply	2	1, 2, 3, 5, 12
4	Design a signal conditioner for the given sensor	Create	2	1, 2, 12
5	Select a sensor for a given application based on its principle of operation	Evaluate	1	1, 2

TEXT BOOKS:

1. Nathan Ida, Senosrs, Actuators, and Their Interfaces-A Multideisciplinary introduction, 2nd Edition, IET London UK, 2020
2. Jacob Fraden, Handbook of Modern Sensors Physics, Designs, and Applications, Fifth Edition, Springer, 2016

REFERENCE BOOKS:

1. John G. Webster, The Measurement Instrumentation and Sensors, CRC Press, 1999
2. Francisco André Corrêa Alegria, Sensors and Actuators, World Scientific Publichisng Co. Pvt. Ltd., 2022.
3. Ammar Rayes, Samer Salam, “Internet of Things from Hype to Reality”, Springer, 2022.