



Lesson Plan

Semester: III

Year: 2022-2023

Course Title: Foundation of Cyber-Physical Systems	Course Code: 21AI34
Total Contact Hours (L: T: P):	3:0:1
SEE Marks: 100	CIE Marks: 100
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Checked By:	Date:

Course Overview

CPSs are integrations of computation, networking, and physical processes: the combination of several systems of different nature whose main purpose is to control a physical process and, through feedback, adapt itself to new conditions, in real time. CPS plays a significant role in the applications like Smart homes, Smart hospitals, Smart Industries, Smart Cities, and etc.

According to Gartner, it is foreseen that by 2025, 50% of public institutions and companies operating in manufacturing will merge their cyber-physical and supply chain security teams under a single head of security reporting directly to the administrative supervisor or the CEO, which means that physical systems will be integrated with the supply chain and the IT infrastructure in the coming years.

Course Outcomes (CO): After completing the course, the students will be able to	
CO1	Understand and apply the knowledge of engineering specialization to address the complex engineering problems
CO2	Analyse the various Cyber-Physical components used in solving the real-world problem
CO3	Design solution for complex engineering problem using Cyber Physical Systems
CO4	Communicate effectively and collaborate in group to carryout Cyber Physical System activities
CO5	Demonstrate design skills to solve inter-disciplinary problems using modern tools effectively by exhibiting team work through oral presentation and written reports.



Course Content

UNIT – I	8 Hrs.
Introduction, CPS concept and requirements, CPS Architecture, CPS Applications: CPS for Vehicular Environments, CPS for Agriculture, CPS for Health and Medical Sciences, CPS for the Smart Grids, Future aspects of CPS, Challenges and Opportunities.	
UNIT – II	10 Hrs.
Computer Architecture-Processors, Basic System Architecture, Interrupts, CISC and RISC, Digital Signal Processors, Memory-RAM and ROM, Input/ Output: Programmed I/O, Interrupt-driven I/O, Direct Memory Access (DMA)-Standard block transfer, Demand-mode transfers, Fly-by transfer, Data-chaining transfers. Parallel and Distributed Computers-Introduction to parallel architectures, SIMD computers, MIMD computers, Embedded Computer Architecture.	
UNIT-III	9 Hrs.
Introduction, Hardware Components- Sensors, Actuators, IO Interfaces, Processor Complex or System on Chip (SoC), Processor and IO Interconnection, Bus Interconnection, High-Speed Serial Interconnection, Low-Speed Serial Interconnection, Firmware Components - Boot Code, Device Drivers, Operating System Services.	
UNIT – IV	8 Hrs.
Sensor Definition, Use of Sensors, Sensor Network Definition and the Use of Sensor Networks, Traditional Sensor Networks vs. WSNs, Types of Sensors, Sensor Performance, Smart Sensors, Sensor Networks and Associated Technologies: Wireless Sensor Networks as Sensor Networks and Smart Sensor Networks.	
UNIT – V	8 Hrs.
Electro Magnetic Actuators, Electrostatic Actuators, Electro-optic devices, Piezoelectric actuators. Robotic Application: Introduction, Robotic Arm, Sensing, Actuation, Automation and Autonomy.	

Text Books	
1	Cyber-Physical System Design with Sensor networking Technologies, Control, Robotics and Sensor Series, Edited by SherAli Zeadally and Nafaa Jabeur ISBN 978-1-84919-825-7
2	Designing Embedded Hardware, John Catsoulis, 2nd Edition, O'Reilly Media, 2005, ISBN: 0-596-00755-8.
3	Real-Time Embedded Components and Systems with LINUX and RTOS, S. Siewert and J. Pratt, 2016, ISBN: 978-1-942270-04-1.
4	Sensors and Transducers: Characteristics, Applications, Instrumentation, Interfacing, M.J Usher, D.A Keating, Second Edition, MACMILLAN PRESS LTD, ISBN-978-1-349-13345-1.



Unit and Chapter wise Plan

Unit I

Chapter Number and Title: Cyber Physical Systems Basics and Fundamentals	Planned Hours: 08
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Learning Objectives

Sl. No.	Objectives
1	Understand the concept of Cyber-physical Systems and its architecture
2	Classify the Cyber and Physical processes
3	Summarize the Various applications of CPS

Lesson Schedule	
Class No.	Portion covered per Hour
1	Orientation
2	Introduction
3	CPS concept and requirements
4	CPS Architecture
5	CPS Applications: Vehicular CPS, Agriculture CPS
6	CPS Applications: Health CPS, Smart Grids
7	CPS Applications: Other Applications
8	Future aspects of CPS, Challenges and Opportunities

Model Questions

- Define CPS and Describe the Main Pillars of CPS
- Describe the architecture of the Health CPS
- Differentiate the Three-tier and multi-tier architecture
- List and explain the typical properties of CPS
- Discuss the requirements of the Health CPS

Unit II

Chapter Number and Title: Embedded System Components	Planned Hours: 08
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Learning Objectives

Sl. No.	Objectives
1	Understand the concepts of Microprocessor, micro-controllers and other essential components of the General Purpose and Embedded Computers



2	Describe and distinguish the different Computer Architectures
3	Sense the usage of different hardware components to solve the real-world application

Lesson Schedule	
Class No.	Portion covered per Hour
1	Introduction
2	Computer Architecture-Processors
3	Basic System Architecture, Interrupts
4	CISC and RISC, Digital Signal Processors
5	Memory-RAM and ROM, Input/ Output: Programmed I/O Interrupt-driven I/O Direct Memory Access (DMA)-Standard block transfer
6	Demand-mode transfers, Fly-by transfer, Data-chaining transfers
7	Parallel and Distributed Computers-Introduction to parallel architectures
8	SIMD computers, MIMD computers
9	Embedded Computer Architecture
10	Embedded Computer Architecture (Contd.)

Model Questions

1. Describe the Embedded Computer Architecture
2. How Desktop Computers software layers are different from the Embedded Systems software layers
3. Discuss how Micro-controllers are different form Micro-processors
4. In what way Harvard Architecture is Advantageous than the Von Neuman Architecture
5. Discuss EPROM in detail

Unit III

Chapter Number and Title:	Planned Hours: 08
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Learning Objectives

Sl. No.	Objectives
1	Identify the Sensors and Actuators used in the CPS Applications
2	Discuss the role of Processors and I/O devices used in CPS Applications
3	Use of different firmware and operating systems services

Lesson Schedule	
Class No.	Portion covered per Hour
1	Introduction



2	Hardware Components - Sensors, Actuators
3	IO Interfaces, Processor Complex or System on Chip (SoC)
4	Processor and IO Interconnection
5	Bus Interconnection,
6	High-Speed Serial Interconnection
7	Low-Speed Serial Interconnection
8	Firmware Components - Boot Code, Device Drivers
9	Operating System Services

Model Questions

1. Discuss the role of Sensors and Actuators in solving the real-world Problem
2. Differentiate the High Speed and Low Speed Serial Interconnections
3. Explain NTSC Vision Subsystem in Stereo-Vision Tracking System
4. List the features of Tilt/Pan Servo Subsystem in Stereo-Vision Tracking System
5. Illustrate the Taxonomy of Processor-IO Interconnection Strategies

Unit IV

Chapter Number and Title: Sensors	Planned Hours: 08
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Learning Objectives

Sl. No.	Objectives
1	Understand the Sensor networks and associated Technologies
2	Identify the Type of Sensors
3	Contrast the Traditional Sensor Networks vs. Wireless Sensor Networks

Lesson Schedule	
Class No.	Portion covered per Hour
1	Introduction
2	Sensor Definition, Use of Sensors
3	Sensor Network Definition and the Use of Sensor Networks
4	Traditional Sensor Networks vs. WSNs
5	Types of Sensors Sensor Performance, Smart Sensors
6	Types of Sensors, Sensor Performance, Smart Sensors (Contd.)
7	Sensor Networks and Associated Technologies: Wireless Sensor Networks as Sensor Networks and Smart Sensor Networks.
8	Sensor Networks and Associated Technologies (Contd.)



Model Questions

1. List and explain the different sensor types in detail
2. How Wireless Sensors are different from traditional Sensor Networks
3. Discuss the Applications of Wireless Sensor Networks in the Present World
4. Give the differences between the Smart Sensors and Sensors
5. Discuss Sensor Performance

Unit V

Chapter Number and Title: Actuators	Planned Hours: 08
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Learning Objectives

Sl. No.	Objectives
1	Understand the actuators and associated Technologies
2	Identify the Type of Type of actuator needed by the applications
3	Summarize the concepts of actuation and automation

Lesson Schedule	
Class No.	Portion covered per Hour
1	Introduction
2	Electro Magnetic Actuators
3	Electrostatic Actuators, Electro-optic devices
4	Piezoelectric actuators
5	Introduction to Robotic Application
6	Robotic Arm, Sensing
7	Actuation, Automation and Autonomy
8	Actuation, Automation and Autonomy (Contd.)

Model Questions

1. What do you mean by relays and how they are useful in the current situation
2. Discuss piezoelectric Actuators
3. Discuss the Sensors and Actuators used in the Robotic Application
4. Illustrate the Robotic arm with neat sketch

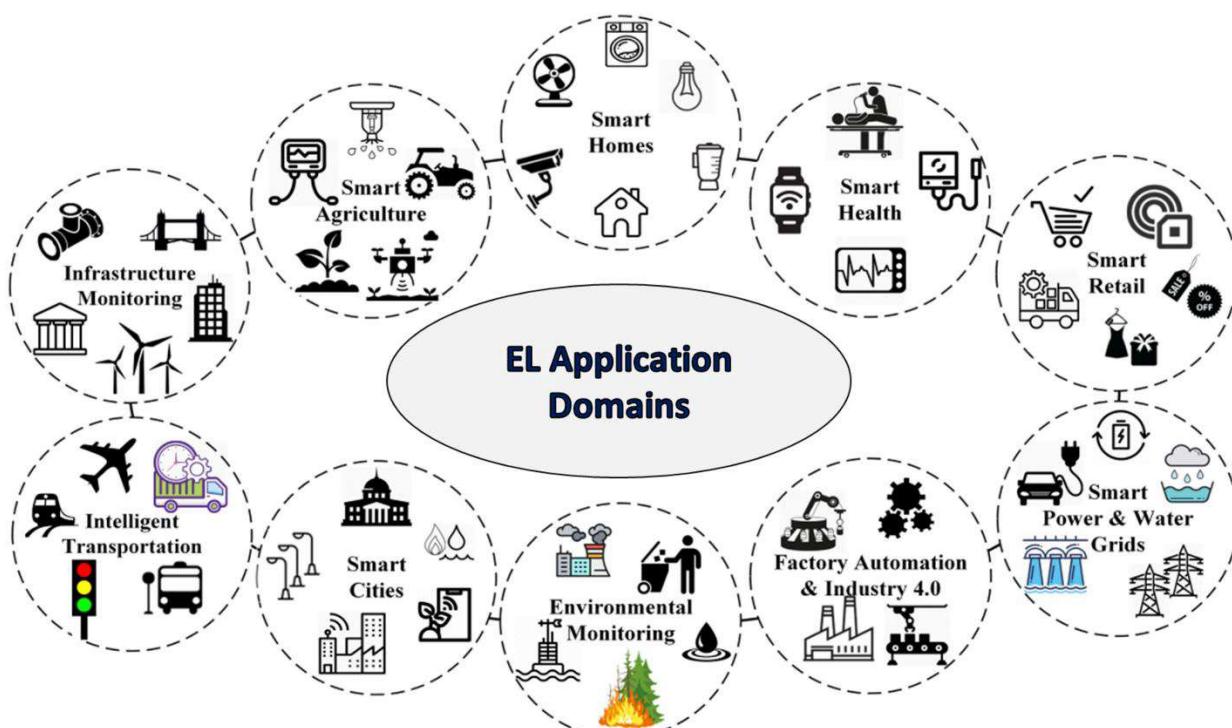


Evaluation Scheme

Continuous Internal Evaluation (CIE) (Theory – 100 Marks)	
Evaluation method	Course with EL
Quiz -1	10
Test -1	50
Quiz -2	10
Test-2	50
Quiz -3	10
Test -3	50
EL	20
Total – theory	100 (Q1+Q2+Q3+Avg. (Test)+EL)

Experiential Learning Details

- Students should carry out the detailed study on the domains given in the below Figure



- Expected Outcome
 - Detailed Report of 20 to 25 Pages
 - Plagiarism should be less than 15%