COURSE CONTENT

CYBER PHYSICAL SYSTEMS								
III Semester: CSE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
		L	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
2235833	**Foundation**	3	0	0	3	40	60	100
Contact Classes: 45	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes: 45**		
Prerequisites: Knowledge of Computer Networks								

Course Overview:

This course introduces the fundamental concepts and principles of Cyber-Physical Systems (CPS), focusing on the integration of computational and physical components. It covers symbolic synthesis techniques, system modeling, and controller design for dynamic environments. Students will study security challenges, synchronization issues, and real-time scheduling in distributed CPS.

Course Objectives:

1. To understand the fundamental concepts, architecture, and characteristics of Cyber-Physical Systems (CPS).
2. To study symbolic synthesis techniques and controller design for CPS.
3. To analyze security requirements, attack models, and defense mechanisms in CPS environments.
4. To explore synchronization, distributed consensus, and real-time scheduling in CPS.
5. To learn model integration techniques and formal methods for designing reliable CPS applications.

Course Outcomes: After Completion of the Course, Students should be able to

1. Understand the fundamental concepts, architecture, and characteristics of Cyber-Physical Systems.
2. Apply symbolic synthesis techniques to model and design controllers for CPS.
3. Analyze security requirements, attack models, and countermeasures in Cyber-Physical Systems.
4. Evaluate synchronization methods, distributed consensus algorithms, and real-time scheduling techniques.
5. Develop integrated CPS models using formal methods and semantic frameworks for real-world applications.

UNIT - I

Symbolic Synthesis for Cyber-Physical Systems

Introduction and Motivation, Basic Techniques - Preliminaries, Problem Definition, Solving the Synthesis Problem, Construction of Symbolic Models, Advanced Techniques: Construction of Symbolic Models, Continuous-Time Controllers, Software Tools

UNIT - II

Security of Cyber-Physical Systems

Introduction and Motivation, Basic Techniques - Cyber Security Requirements, Attack Model, Countermeasures, Advanced Techniques: System Theoretic Approaches

UNIT - III

Synchronization in Distributed Cyber-Physical Systems: Challenges in Cyber-Physical Systems, A Complexity-Reducing Technique for Synchronization, Formal Software Engineering, Distributed Consensus Algorithms, Synchronous Lockstep Executions, Time-Triggered Architecture, Related Technology, Advanced Techniques

UNIT - IV

Real-Time Scheduling for Cyber-Physical Systems

Introduction and Motivation, Basic Techniques - Scheduling with Fixed Timing Parameters, Memory Effects, Multiprocessor/Multicore Scheduling, Accommodating Variability and Uncertainty

UNIT - V

Model Integration in Cyber-Physical Systems

Introduction and Motivation, Causality, Semantic Domains for Time, Interaction Models for Computational Processes, Semantics of CPS DSMLs, Advanced Techniques, ForSpec, The Syntax of CyPhyML, Formalization of Semantics, Formalization of Language Integration.

TEXT BOOKS:

1. Raj Rajkumar, Dionisio De Niz, and Mark Klein, Cyber-Physical Systems, Addison-Wesley Professional.
2. Rajeev Alur, Principles of Cyber-Physical Systems, MIT Press, 2015

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1. Raj Rajkumar, Dionisio De Niz, and Mark Klein, Cyber-Physical Systems, Addison-Wesley Professional.
2. Rajeev Alur, Principles of Cyber-Physical Systems, MIT Press, 2015.
3. Edward A. Lee and Sanjit A. Seshia, Introduction to Embedded Systems: A Cyber-Physical Systems Approach, MIT Press.
4. Thomas A. Henzinger, The Theory of Hybrid Automata, Springer.□ Thomas A. Henzinger, The Theory of Hybrid Automata, Springer.

ELECTRONIC RESOURCES:

1. **https://nptel.ac.in/courses**
2. **https://ocw.mit.edu/**
3. **https://www.cis.upenn.edu/~alur/**
4. **https://ieeexplore.ieee.org/**
5. **https://dl.acm.org/**

MATERIALS ONLINE:

1. Course template
2. Tutorial question bank
3. Tech talk and Concept Video topics
4. Open-ended experiments
5. Definitions and terminology
6. Assignments
7. Model question paper – I
8. Model question paper – II
9. Lecture notes
10. E-Learning Readiness Videos (ELRV)