

NIRMA UNIVERSITY
School of Technology, Institute of Technology
B.Tech. Electronics & Communication Engineering
Semester - VII
Department Elective IV

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Course Code	2ECDE11
Course Title	Cyber Physical System

Course Outcomes (COs):

At the end of the course, the students will be able to -

1. address challenges in implementing a cyber-physical system from a computational perspective.
2. integrate real-valued and dense time real-time systems with software-based discrete automated control.
3. design of cyber-physical systems using formal methods.
4. validate cyber-physical system problems for safety assurance and security aspects.

Syllabus

Teaching Hours: 45

UNIT I: Introduction to Cyber-Physical Systems

05

Cyber-Physical Systems (CPS) in the real world, Basic principles of design and validation of CPS, Industry 4.0, AutoSAR, IIOT implications, Building Automation, Medical CPS

UNIT II: CPS - Platform Components

06

CPS HW platforms - Processors, Sensors, Actuators, CPS Network – Wireless Hart, CAN, Automotive Ethernet, CPS Software stack - RTOS, Scheduling Real-Time control tasks

UNIT III: Principles of Automated Control Design

08

Basic control theory, Dynamical Systems, and Stability, Controller Design Techniques, Stability Analysis: CFLs, MLFs, stability under slow switching, Performance under Packet drop and Noise, Tutorial: MATLAB toolboxes - Simulink, State flow

UNIT IV: CPS Implementation

07

Features, software components, Mapping software components to ECUs, CPS Performance Analysis - effect of scheduling, bus latency, sense and actuation faults on control performance, network congestion, Control, Bus and Network Scheduling using True-time

UNIT V: Formal Methods for Safety Assurance of Cyber-Physical Systems

07

Advanced automata-based modeling and analysis, Basic introduction and examples, Timed and Hybrid Automata Formal Analysis, Flow pipe construction, reachability analysis, Analysis of CPS Software, Weakest Pre-conditions, Hybrid Automata Modeling

UNIT VI: Secure Deployment of CPS

06

Attack models, Secure Task mapping and Partitioning, State estimation for attack detection, Case study - Vehicle ABS hacking, Power Distribution, and Attacks on Smart Grids

UNIT VII: CPS Case Studies and Tutorials

06

Automotive: SW controllers for ABS, ACC, Lane Departure Warning, Suspension Control, Healthcare: Artificial Pancreas/Infusion Pump/Pacemaker, Green Buildings: automated lighting, AC control, and Agriculture

Self-Study:

The self-study contents will be declared at the commencement of the semester. Around 10% of the questions will be asked from self-study contents.

Suggested Readings:

1. E.A.Lee, Sanjit Seshia, Introduction to Embedded Systems: A Cyber-Physical Systems Approach, MIT Press
2. Rajeev Alur, Principles of Cyber-Physical Systems, MIT Press

L = Lecture, T = Tutorial, P = Practical, C = Credit