SCSA1701	CYBER PHYSICAL SYSTEMS	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

- **To introduce basics of cyber-physical system and Industrial revolution 4.0 concepts.**
- **To develop an exposition of the challenges in implementing a cyber-physical system.**
- **To analyze the functional behaviour of CPS based on standard modelling formalisms.**
- **To design CPS requirements based on operating system and hardware architecture constraints.**
- **To understand the concepts involved in Cyber Physical Systems Security.**

UNIT 1 INTRODUCTION TO INDUSTRY 4.0 AND CYBER PHYSICAL SYSTEM 9 Hrs.

Industry 4.0 - Globalization and Emerging Issues, The Fourth Revolution - Smart and Connected Business Perspective, Basics of Industrial IoT - Industrial Processes - Industrial Sensing and Actuation, Industrial Internet Systems **- Basic principles of design and validation of CPS - Cyber-Physical Systems (CPS) in the real world- Next Generation Sensors, Collaborative Platform and Product Lifecycle Management,** Augmented Reality and Virtual Reality**, Artificial Intelligence, Trends of Industrial Big Data and Predictive Analytics for Smart Business Transformation.**

UNIT 2 EMBEDDED SYSTEMS MODELING AND DESIGN AND CPS

9 Hrs. Platform components - Embedded Systems definition, specification, and languages. Concepts, requirements, examples. Embedded system models at different abstraction levels. **Test benches, design under test, Intellectual Property components. Discrete event simulation, semantics, algorithms. Design,** analysis techniques for decentralized computer architectures**, communication, and hardware-software systems.** - Cyber Physical System Hardware Platform **- Processors,** Sensors, Actuators **- Network – Wireless Hart, CAN, Automotive Ethernet – Software stack -**Real-Time Operating system (RTOS) **-** Scheduling Real Time control tasks.

UNIT 3 SENSORS, ACTUATORS AND SENSOR NETWORKS

9 Hrs. Sensors, Actuators and Sensor Networks and Real-Time and Distributed Systems **-** Fundamental principles and applications of sensors, actuators. **Smart sensors** Introduction to signal processing and sensor/actuator networks, **deployment and architecture,** wireless communication**,** multiple access control layer, data gathering, routing and querying, collaborating signal processing **- Time dependent systems, clock synchronization, real-time communication protocols, specification of requirements,** task scheduling**. Validation of timelines, real-time configuration management.** Middleware architecture for distributed real-time and secure services.

UNIT 4 SECURITY OF CYBER PHYSICAL SYSTEMS

9 Hrs. Security of Cyber Physical Systems -Embedded and CPS security - attacks and countermeasures, authentication, identification, confidentiality, data integrity, authorization, access control, malware attacks and counter-measures, security protocols. **Privacy issues - vehicular devices and smart metering.** Applications of public key and symmetric cryptography, **-** digital certificates, credentials**. Security and vulnerability of cyber-physical infrastructure networks -** Mobile and wireless network security**, Robust wireless infrastructure -** Cloud computing and data security, **Event Awareness and System Monitoring for Cyber Physical Infrastructure.**

UNIT 5 CYBER-PHYSICAL SYSTEMS CASE STUDIES AND PROJECTS

9 Hrs. Cyber-Physical Systems Case Studies and Projects - Automotive: SW controllers for Antilock braking system, Adaptive Cruise Control, Lane Departure Warning, Suspension Control **-** Healthcare: Artificial Pancreas**/Infusion Pump/Pacemaker -** Green Buildings: automated lighting, AC control - power distribution grid - robotics - civil infrastructure – avionics – Transportation.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: An ability to expose the student to real world problems in CPS and Industrial revolution 4.0 best practices.
CO2: Identify the limitations of some computational models.
CO3: Apply the theoretical knowledge the design of compilers.
CO4: Student can Analyze and verify the correctness of CPS implementations against system requirements and timing constraints.
CO5: Categorize the essential modelling formalisms of Cyber-Physical Systems (CPS).
CO6: Ability to understand cyber modelling system.

TEXT / REFERENCE BOOKS

1. **Alasdair Gilchrist, "Industry 4.0: The Industrial Internet of Things", Apress.**
2. **Sabina Jeschke, Christian Brecher, Houbing Song, Danda B. Rawat, "Industrial Internet of Things: Cyber manufacturing Systems", Springer.**

3. **Edward A. Lee and Sanjit A. Seshia, "Introduction to Embedded Systems, A Cyber-Physical Systems Approach", Second Edition, http://LeeSeshia.org, ISBN 978-1-312-42740-2, 2015.**
4. **Rajeev Alur," Principles of Cyber-Physical Systems". MIT Press. 2015.**
5. **K. J. Astrom and R. M. Murray," Feedback Systems: An Introduction for Scientists and Engineers", Prince- ton University Press, 2009.** http://www.cds.caltech.edu/~murray/amwiki/index.php/Main_Page.
6. **Sajal Das, Krishna Kant, and Nan Zhang, "Securing Cyber-Physical Critical Infrastructure – Foundations and Challenges", Morgan Kaufmann, 2012.**

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100	**Exam Duration: 3 Hrs.**
PART A: 10 Questions of 2 marks each - No choice	**20 Marks**
PART B: 2 Questions from each unit with internal choice, each carrying 16 marks	**80 Marks**