Birla Institute of Technology & Science, Pilani
Hyderabad Campus

INSTRUCTION DIVISION
FIRST SEMESTER
Course Handout Part II

In addition to part-I (General Handout for all courses appended to the time table) this portion gives further specific details regarding the course.

Course No. :

Course Title : *Cyber Physical Systems and Security*

Instructor-in-Charge : *Dr. Rajib Ranjan Maiti*

1. Scope and Objectives

Upon successful completion, you should be able to:

1. Describe the basic concepts of cryptography are used for ensuring security of cyber-physical systems
2. Describe the basic design, architecture and design principles of cyber physical systems
3. Design CPS, identify safety requirements, understand asynchronous model of CPS, identify sensors and actuators in CPS, learn the dynamics in the systems and create model of CPS using timed automata
4. Identify the sources of vulnerability in a cyber physical system systematically via attack surfaces
5. Determine how security is incorporated at different abstractions and at different components of cyber physical systems

2. Pre requisites: Programming in Python.

3.a. Text Book

- T1: Rajeev Alur, "Principles of Cyber-Physical Systems", MIT Press
- T2: Edward A. Lee and Sanjit A. Seshia, "Introduction to Embedded Systems, A Cyber-Physical Systems Approach", Second Edition, MIT Press, ISBN 978-0-262-53381-2, 2017, available for download [http://leeseshia.org/]

3.b. Reference Books

- R1: Derek Molloy, "Exploring Raspberry Pi: Interfacing to the Real World with Embedded Linux", Wiley, ISBN 978-1-119-18868-1, 2016
- R2: Danda B. Rawat, Joel J.P.C. Rodrigues, Ivan Stojmenovic, "Cyber-Physical Systems: From Theory to Practice", CRC Press

4. Course Plan

Lec. No.	Learning Outcomes	Topics to be covered	Chapter in the Text Book
1	To introduce CPS	Features of CPS, Overview of the Topics in CPS	T1: Ch1
2-5	To understand the design of CPS	Basics of synchronous model, reactive components, extended state machine, components and their properties, integrating	T1: Ch2

		components, Synchronous Designs and examples,	
6-9	To learn safety requirements	Fundamentals of safety requirements, safety specification, role of requirements in system design, system invariants and verification of invariants, enumerative search for property verification, symbolic search for property verification: DFS and BFS, Reduced Ordered Binary Decision Diagrams,	T1: Ch3
9-12	To learn asynchronous model of CPS	Introduction to asynchronous model and process, extended state machine, asynchronous design primitives, deadlock handling mechanisms, asynchronous coordination protocols: leader election, reliable transmission, wait-free consensus	T1: Ch4
12-15	To understand liveliness requirements	Basics of liveliness requirements, temporal logic, LTL specifications, LTL specification for asynchronous process, model checking, Buchi automata, nested symbolic search, proving liveliness,	T1: Ch5
16-17	To know sensors and actuators	Models of sensors and actuators, common sensors and common actuators, Measuring Tilt and Acceleration, Measuring Position and Velocity, Measuring Rotation, Light-Emitting Diodes, Motor Control	T2: Ch7
18-21	Case study on real CPS	Physical structure and communication protocols in water treatment and distribution systems	Lecture Notes
22-24	To understand dynamical systems	Continuous time models: evolving inputs and outputs, models with disturbance, stability, linear systems: linearity, solutions to linear differential equations, designing controllers: Open-Loop vs. Feedback Controller, Stabilizing Controller, PID Controllers, analysis techniques: numerical simulations, Barrier Certificates	T1: Ch6
25-27	To understand Real-Time Scheduling	Basics of Real-Time Scheduling, scheduler architecture, periodic job model, schedulability, EDF scheduling, Utilization-Based Schedulability Test, Fixed-Priority Scheduling, Schedulability Test for Rate-Monotonic Policy	T1: Ch8
28-32	To learn attack detection in CPS	Physics-Based Attack Detection in Cyber-Physical Systems, Formal Security Analysis of Industrial Control Systems	Lecture notes
33-39	To learn real world CPS systems	Rule-based and axiomatic invariants for securing a water treatment and distribution systems	Lecture notes
40	To demonstrate CPS projects	Project showcasing	Lecture notes

5. Evaluation Scheme

5.a Major Components

Component	Duration	Weightage	Date&Time	Mode
Projects and Assignments	-	**30%**		Open Book
Mid-Term exam	90 mins	**25%**		Close Book
Comprehensive	3 hours	**45%**		Close Book

6. Chamber Consultation:

7. Notices:

8. Make-up Policy:

9.Academic Honesty and Integrity Policy: Academic honesty and integrity are to be maintained by all the students throughout the semester and no type of academic dishonesty is acceptable.

Instructor-in-charge